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Health Effects Associated with Wastewater Treatment and Disposal Systems State-of-the-Art Review. Volume II: Annotated Bibliography Part 2: M through Z

SCS Engineers
Long Beach, CA

Prepared for

Health Effects Research Lab.
Research Triangle Park, NC

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Health Effects Associated with Wastewater Treatment and Disposal Systems State-of-the-Art Review

Volume II, Part 2

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This annotated bibliography covers the source documents used in the main text. For individual articles a brief summary of the major topics of discussion is presented. For major reports a short description of their content is provided. A subject index to the bibliography is provided at the back of Volume II, Part 2.

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STATE-OF-THE-ART REVIEW

VOLUME II

ANNOTATED BIBLIOGRAPHY
PART II: M THROUGH Z

by

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U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
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FOREWORD

The many benefits of our modern, developing, industrial society are accompanied by certain hazards. Careful assessment of the relative risk of existing and new man-made environmental hazards is necessary for the establishment of sound regulatory policy. These regulations serve to enhance the quality of our environment in order to promote the public health and welfare and the productive capacity of our Nation's population.

The Health Effects Research Laboratory, Research Triangle Park, conducts a coordinated environmental health research program in toxicology, epidemiology, and clinical studies using human volunteer subjects. These studies address problems in air pollution, non-ionizing radiation, environmental carcinogenesis and the toxicology of pesticides as well as other chemical pollutants. The Laboratory participates in the development and revision of air quality criteria documents on pollutants for which national ambient air quality standards exist or are proposed, provides the data for registration of new pesticides or proposed suspension of those already in use, conducts research on hazardous and toxic materials, and is primarily responsible for providing the health basis for non-ionizing radiation standards. Direct support to the regulatory function of the Agency is provided in the form of expert testimony and preparation of affidavits as well as expert advice to the Administrator to assure the adequacy of health care and surveillance of persons having suffered imminent and substantial endangerment of their health.

Pursuant to the overall mission of the laboratory to investigate the human health effects of environmental pollution, this contract was let to summarize the state of knowledge regarding the health effects associated with various methods of handling wastewaters and sewage sludges. Subjects of interest include biological as well as chemical pollutants. Pathways of these agents from wastewater streams to man were delineated.

F. G. Hueter, Ph.D.
Director
Health Effects Research Laboratory

ABSTRACT

This annotated bibliography covers the source documents used in the main text. For individual articles a brief summary of the major topics of discussion is presented. For major reports a short description of their content is provided. A subject index to the bibliography is provided at the back of Volume II, Part 2.

Macek, K.J. and S. Korn.

Significance of the Food Chain in DDT Accumulation by Fish.

Journal of the Fisheries Research Board of Canada. 27:1496-1499.
August 1970.

Key Words: DDT, livestock, fish.

Abstract:

Brook trout accumulated approximately 10 times more of the available DDT from the food than directly from the water. Since, in aquatic environments, the concentration of DDT is usually much higher in the food chain than in the water, we suggest that the food chain is the major source of DDT for fish in natural waters.

Mack, W.N.

Poliovirus in a Water Supply; Joint Discussion.

JAWWA. 65(5):347-348. May 1973.

Key Words: viruses, surface water (fresh).

Abstract:

There is no evidence that the virus found in the well water was the cause of the gastroenteritis reported by the patrons of a certain restaurant. It does show that viruses are viable and can survive where the bacteria do not. Except for the illness reported by the patrons, there was little evidence that the well water was contaminated and it required a great deal of concentration of the samples before the coli organisms and the virus could be detected.

This is the first isolation of a virus from drinking water in the U.S. Epidemiological evidence indicates that viruses can contaminate water sources, resulting in hepatitis. With increased population and inadequate treatment of wastewaters, other episodes can occur. The possibility of water supplies becoming biologically contaminated is a real one. Chlorination alone is not the answer, as the electron microscope pictures indicate. Chlorinated sewage is not satisfactory - wastewater must be properly cleaned before it is deposited upon the earth's surface so that drinking water will not be contaminated.

Mackay, D. and P.J. Leinonen.

Rate of Evaporation of Low-Solubility Contaminants from Water Bodies to Atmosphere.

Environmental Science and Technology. 9(13):1178-1180. December 1975.

Key Words: chlorinated hydrocarbons, pesticides, surface water (fresh), surface water (marine), drinking and recreational water, fish.

Abstract:

The equations presented in the report can be used to predict the approximate rates of evaporative loss of low-solubility contaminants in an air-water system; however, it is very desirable to obtain specific mass transfer rates for that system, particularly the coefficient for the controlling phase.

Mackay, D.W., W. Halcrow, and I. Thornton.

Sludge Dumping in the Firth of Clyde.

Marine Pollution Bulletin. 3(1):7-10. January 1972.

Key Words: lead, copper, chromium, zinc, nickel, cadmium, manganese, fish.

Abstract:

Sewage sludge contaminated with a variety of heavy metals has been dumped into the Firth of Clyde for some years. Since 1969 a survey of heavy metal contamination of sediments and animals has been carried on. This report summarizes the findings that have emerged so far.

Mackenthun, K.M.

Nitrogen and Phosphorus in Water: An Annotated Selected Bibliography of Their Biological Effects.

U.S. Public Health Service. Division of Water Supply and Pollution Control, Washington, D.C., 1965. 139p.

Key Words: nitrates, ammonia, nitrites, phosphates, surface water (fresh), surface water (marine).

Abstract:

This is an early write-up of literature concerning N and P in water. The abstracts include data.

Mackenthun, K.M. and L.E. Keup.

Biological Problems Encountered in Water Supplies.

JAWWA. 62(8):520-526. August 1970.

Abstract:

Although none of the organisms found in surface waters may be injurious to health, domestic water supplies must be free of such organisms, since they, or their by-products, may interfere with filtration and cause consumer complaints. The authors compiled various reports and surveys.

MacKenzie, R.D., R.U. Byerrum, C.F. Decker, C.A. Hoppert, and R.F. Langham.

Chronic Toxicity Studies. II: Hexavalent and Trivalent Chromium Administered in Drinking Water to Rats.

AMA Archives of Industrial Health. 18:232-234. 1958.

Key Words: chromium, drinking and recreational water

Abstract:

Five groups of rats were given water containing between 0.45 and 11 ppm of chromium as chromate ion for a year. No differences were observed between these groups and the controls as to water intake, food consumption, or weight gain; nor did an analysis of blood at monthly intervals or examination of tissues at six months or a year show any significant differences between any of the groups given chromium and the control group.

Kidney, liver, and femur were analyzed for chromium at the end of six months, and these plus spleen were analyzed at the end of one year. There was an abrupt rise in tissue chromium concentration when rats ingested water having concentrations above 5 ppm of chromate ion.

Two groups of rats were given water containing 25 ppm of chromium as hexavalent and trivalent chromium, respectively, for one year. No toxic symptoms were observed in either group. However, tissue concentrations of chromium were approximately nine times higher in the group given hexavalent chromium. This suggests that chromate ion is absorbed to a much greater extent than trivalent chromium at this level.

Mahoney, L.E., C.T.E. Friedmann, R.A. Murray, E.L. Schulenburg, and G.A. Heidbreder.

A Waterborne Gastroenteritis Epidemic in Pico Rivera, Ca.

Public Health. 64(10):963-968. 1974.

Key Words: drinking and recreational water epidemiology.

Abstract:

An outbreak of gastroenteritis in a trailer park in Pico Rivera, California, led to investigation of the water supply and an epidemiological survey of residents of the community. The syndrome called "sewage poisoning" was believed to be responsible.

Maier, W.J., H.L, McConnell, and L.E. Conroy.

A Survey of Organic Carbon Constituents in Natural Fresh Waters.

University Of Minnesota, Minneapolis, Department of Civil and Mineral Engineering, 1974. 12p. (Available from National Technical Information Service (NTIS) as PB-236 794).

Key Words: total organic carbon, surface water (fresh).

Abstract:

The paper describes the initial phase of a study of organic and inorganic carbon measurements in some of the major bodies of water in Minnesota. Concentration levels are described and discussed in terms of flow variation and seasonal changes. Information about sources and composition of organic materials are reviewed and discussed.

Mairs, K.H.

Development of Methods for Controlling the Cadmium and Zinc Content of Water.

University of Rhode Island, Kingston, Department of Chemical Engineering, 1974. 7p. (Available from National Technical Information Service (NTIS) as PB-238 299).

Key Words: cadmium, zinc.

Abstract:

A study has been made to determine whether cadmium as an impurity in zinc used in the manufacture of brass or galvanized water pipe can contribute a hazardous contamination to mildly aggressive water. Only minor quantities of cadmium have been found in such products and no tendency has been observed for the selective corrosion of cadmium. Observations suggest that cadmium hazard from such a source is very unlikely.

Majumdar, S.B., U.H. Ceckler, and O.J. Sproule.

Inactivation of Poliovirus in Water by Ozonation.

JWPCF. 45(12):2433-2443. December 1973.

Key Words: polio virus, ozonation.

Abstract:
The following conclusions can be drawn from this study:

1. A threshold concentration of ozone exists for inactivation of poliovirus. Based on the findings of inactivation studies in triple distilled water, the threshold value may be taken as 1.0 mg/l.

2. The relationship of the ozone concentration and the contact time with the survival of poliovirus may be expressed by the following:

$$Ct = 0.18\ S^{-0.86} \quad C < 1.0\ \text{mg/l}$$

$$Ct = 0.13\ S^{-0.36} \quad C > 1.0\ \text{mg/l}$$

It is, therefore, concluded that two distinct rate mechanisms exist, one above and another below the threshold concentration, 1.0 mg/l.

3. The rate equations for inactivation of poliovirus in triple distilled water and primary and secondary wastewaters may be represented by the following general equation:

$$\frac{dC_v}{dt} = -k_1 C_v{}^n C^m$$

Malaney, G.W., P.A. Lutin, J.J. Cibulka, and L.H. Hickerson.

Resistance of Carcinogenic Organic Compounds to Oxidation by Activated Sludge.

JWPCF. 39(12):2020-2029. December 1967.

Key Words: synthetic/organics, activated sludge.

Abstract:

Since the activated sludges from treatment plants in the Nashville area showed essentially the same oxidative powers as those at Columbus, Ohio, it must be concluded that the poor oxidation of the majority of the carcinogenic compounds must reside in a refractory chemical structure. This is not unexpected when the architecture of these compounds is considered. The condensed nuclear hydrocarbons are relatively strain-free. This results from the fact all bond angles are tetrahedral and the orientation about every carbon-carbon bond is the staggered configuration found in the ethane molecule. Such structures are relatively stable.

Of the four aliphatic compounds studied, butylene oxide and propiolactone have been used as aerosol disinfectants; hence, it was expected that they would prove toxic or, at least, resistant to all sludges. However, this did not prove to be true. Thiourea, although structurally related to urea which is a common component of domestic wastes, was not universally amenable to oxidation. Ethyl carbamate, a member of the urethane family, resisted oxidation completely.

Although aniline was oxidized to an appreciable extent in 144 hr, the structurally related bicyclic hydrocarbon benzidine was inhibitory or resistant to all sludges. The stilbene derivative was another bicyclic compound which proved refractory to all but Franklin sludge.

Data for the noncarcinogenic naphthalene were included to show the oxidation pattern of the parent structure of the bicyclic condensed nuclear compounds. In contrast to the susceptibility of naphthalene, 2-naphthylamine was resistant or toxic; thus, introduction of the amino group rendered the molecule much more difficult to degrade.

Both of the azo compounds were toxic to all sludges at some time during the 144-hr experiment, although the experimental results are difficult to interpret. Another researcher obtained similar results in a study of aniline-acclimated activated sludge.

The tricyclic condensed structure, dimethylanthracene, was oxidized appreciably by Nashville sludge and slightly by Franklin sludge, but was resistant to Ashland City sludge. The parent hydrocarbon, anthracene, showed the same pattern of oxidation.

Malherbe, H.H. and M. Strickland-Cholmley.

Survival of Viruses in the Presence of Algae.

In: Transmission of Viruses by the Water Route. G. Berg, ed.
J. Wiley, New York, 1965. pp. 449-458.

Key Words: polio virus, chemical treatment.

Abstract:

Seeding a model system of four stabilization ponds, covering one-half acre, with 39 litres of poliovirus 2 added over a period of 20 days produced measurable amounts of virus at the outflow points of all the ponds. The rate of passage of the virus exceeded that indicated by theoretical retention times; although short-circuiting probably occurred, rapid diffusion of virus may have also occurred.

Monitoring of influents and effluents of maturation ponds at two sewage disposal works showed reduction of reovirus and enterovirus levels during passage through the ponds; but small amounts of both viruses were occassionally detected in the final effluents.

Laboratory experiments failed to produce evidence of active removal of poliovirus and reovirus by algae. The observed reduction of enteric virus levels in sewage maturation ponds may result from inactivation by sunlight at the surface; viruses may be destroyed more readily in a shallow stream than in a pond.

Malhotra, S.K., T.P. Parrillo, and A.G. Hartenstein.

Anaerobic Digestion of Sludges Containing Iron Phosphates.

Journal of the Sanitary Engineering Division, ASCE. 97(SA5): 629-646. October 1971.

Key Words: suspended solids, phosphates, anaerobic digestion.

Abstract:

The following conclusions were reached:

1. The high phosphorus removals achieved at conventional activated sludge treatment plants with the precipitation of phosphorus with ferrous-iron, during the primary treatment or in the aeration tanks, will not be drastically reduced by the amount of total phosphorus recycled through the supernatant from the anaerobic digesters used for sludge stabilization.

2. The pH, alkalinity, volatile acids and the percentage of reduction of VM in the test digesters were within the range of their expected values and were not much different from those observed in the control digesters. The alkalinity levels in the test digesters were generally higher than those in the control digester indicating their improved stability.

3. The ferrous-iron in the feed sludge up to a maximum level of 5.55% Fe on the dry solids basis did not upset the gas mixed primary digester or the overall digestion process.

4. The quantity and the quality of the gas produced during digestion was not affected significantly, except that the CO_2 content of the gas produced on the digestion of iron precipitated primary sludge decreased because of the lime used for obtaining good flocculation of sewage with ferrous-iron.

5. A significant uptake of total soluble phosphorus was observed on the digestion of primary sludges with or without ferrous-iron precipitated phosphorus. The TSP concentrations in the digested primary sludges with and without ferrous-iron precipitation were 0.26 mg per l-P and 44.7 mg per l-P, respectively. The corresponding TSP levels in the feed sludges were 2.80 mg per l-P and 80.0 mg per l-P, respectively.

6. The TSP level slightly decreased on the digestion of gravity thickened control waste activated sludge. There was an insignificant decrease of TSP from 122 mg

per l-P in the feed sludge to 117 mg per l-P in the digested sludge at low VM loading rate, but the corresponding decrease in TSP at a higher VM loading rate from 203 mg per l-P in the feed sludge to 173.0 mg per l-P in digested sludge was with a 70% confidence level.

7. The thickened waste activated sludges containing iron precipitated phosphorus resulted in significant releases of phosphorus on digestion. The phosphorus release increased and became more significant with sludges containing more iron insolubilized phosphorus. The digestion of waste activated sludge containing about 5% iron on dry solid basis resulted in an average TSP increase from 20.2 mg per l-P in the feed sludge to 33.0 mg per l-P in the digested sludge with 99% confidence level at low VM loading rate and from TSP of 58.4 mg per l-P to 104.5 mg per l-P, respectively with 99% confidence limit at a higher VM loading rate. This release of phosphorus on digestion was possibly due to the conversion of ferric phosphate to ferrous phosphate plus phosphate ions under the anaerobic conditions in the digester.

Malina, J.F., Jr., K.R. Ranganathan, B.E.D. Moore, and B.P. Sagik.

Poliovirus Inactivation by Activated Sludge.

In: Virus Survival in Water and Wastewater Systems. J.F. Malina, Jr. and B.P. Sagik, eds. University of Texas at Austin, Center for Research in Water Resources, 1974. pp. 95-106.

Key Words: polio virus, activated sludge.

Abstract:
The following conclusions were reached:

1. The performance of conventional activated sludge process in inactivating poliovirus is independent of organic loadings ranging from 0 to 0.51 lb BOD/lb MLSS-day and therefore of the physiological condition of the sludge.

2. The inactivation is independent of hydraulic detention times within the range of 5 to 15 hours and mixed liquor suspended solids concentrations of 1,900 to 2,700 mg/l.

3. Any biochemical difference in the function of oxygen and air in the activated sludge process does not result in significant differences in poliovirus inactivation capacity.

4. The contact stabilization process with a contact time of as low as 16 minutes removes virus at the same efficiency as the conventional activated sludge systems with hydraulic detention times in the range of 5 to 15 hours. These data indicate that the virus adsorption to sludge is almost immediate.

5. No decrease in the inactivation capacity was observed over the long period of continuous virus inoculation of the processes studied. No increase with time of recoverable infective units from the sludge was observed; therefore, the sludges exhibit a permanently inactivating capacity.

6. The results of batch experiments using tritium labeled poliovirus conclusively showed that degradation of virus particles takes place in the sludge virus complex.

7. Association of virus particles with sludge and the recoverability of virus must be considered in evaluating sludge disposal alternatives and in virus monitoring techniques proposed for effluents from wastewater treatment plants.

Malina, J.F., Jr., K.R. Ranganathan, B.P. Sagik, and B.E. Moore.

Poliovirus Inactivation by Activated Sludge.

JWPCF. 47(8):2178-2183. August 1975.

Key Words: polio virus, activated sludge.

Abstract:

The results of batch activated sludge experiments indicate the permanent inactivation of some poliovirus in the sludge-virus complex.

The association of virus particles with sludge and the ability to elute infectious virus particles from sludge solids must be considered in evaluating sludge disposal alternatives and in virus monitoring techniques proposed for effluents of municipal wastewater treatment plants.

Mallmann, W.L. and W.N. Mack.

Biological Contamination of Groundwater.

In: Groundwater Contamination; Proceedings of the 1961 Symposium. Technical Report 61-5. Robert A. Taft Engineering Center, 1961. pp. 35-43.

Key Words: bacteria, viruses, direct contact, groundwater.

Abstract:

Field studies in which test wells surround a recharging well that receives diluted sewage effluent have indicated that:

1. Pollution spreads from the recharging well in the direction of water flow in the aquifer.

2. Bacteria seldom migrate more than 100 feet from the recharging well, and then only during the early phase of aquifer recharge.

3. Particulate material in the recharge water deposits at the point it enters the aquifer, forming a filtering substratum that tends to retain bacteria. As a result, bacteria migrate only a few feet from the filtering substratum forms.

4. In porous soils with low water tables, bacteria disappear from the aquifer soon after recharging ceases.

5. Soluble substances in the recharge water travel farther than the bacteria.

6. Bacteria are removed from the recharge water in the aquifer by adsorption on soil particles and by filtration (straining action) of the particle mass.

Surveys of sources of epidemics due to groundwater contamination indicate that in many cases bacteria have traveled much greater distances than those recorded in experimental tests.

Pollution of groundwater that has caused epidemics has been the result of sudden gross contamination, a situation comparable to the first rush of bacteria through an aquifer before a filtering substratum has developed at the point of entry.

Syndets in sewage lower the surface tension of the water, causing it to wet the substrate so that passage may be

more rapid. Syndets are good suspending agents with the result that bacteria may be carried farther in the soil without deposition. No studies in which syndets had been tested to prove this statement were found in the literature.

Virus diseases have been caused by contaminated groundwater. No field tests have been made to determine the travel of viruses in groundwater. Laboratory tests demonstrate that viruses are generally more resistant to chlorine treatment than bacteria. Field tests demonstrate that viruses pass through complete sewage treatment processes and survive sewage effluent chlorination, as routinely practiced in sewage treatment plants.

The duration of survival in the soil of pathogens such as salmonellae is dependent upon the nature of the soil, the pH, the temperature, and the moisture and salt content. Most pathogens die out rapidly in groundwater.

There is no information available on the period of survival of viruses in groundwaters, although the writers believe this time period is relatively short.

Endemic pollution of groundwater may occur in heavily populated suburban areas where numerous septic tank fields are flooding the groundwater table.

Malone, J.R. and T.L. Bailey.

Oxidation Ponds Remove Bacteria.

Water and Sewage Works. 116(4):136-140. April 1969.

Key Words: bacteria, ponding/land application.

Abstract:

The following conclusions were reached:

1. Properly designed tertiary oxidation ponds following adequate secondary treatment provide an excellent means of bacteria removal.

2. Stream Standards may not be met by using chlorination to reduce coliform bacteria; the oxidation ponds will do this.

3. Oxidation ponds also offer solids removal, BOD reductions, reductions in turbidity, plant breakdown buffering capacity, and are less expensive than chlorination.

4. Oxidation ponds provide reduction in radiation hazards.

5. Additional research is needed to study algae removal from oxidation pond effluent.

Malone, T.C.

In Vitro Conversion of DDT to DDD by the Intestinal Microflora of the Northern Anchovy, _Engraulis mordax_.

Nature. _227_:848-849. August 1970.

Key Words: DDT, fish.

Abstract:

This article discusses the mechanism of conversion of DDT to DDD. It may be an aid in explaining some of the DDT data.

Manahan, S.E. and M.J. Smith.

The Importance of Chelating Agents in Natural Waters and Wastewaters.

Water and Sewage Works. 120(9):102-106. September 1973.

Key Words: manganese, copper, iron, zinc, surface water (fresh), surface water (marine).

Abstract:

This paper is a good overview of the role of metal chelating agents in water pollution.

A practical example of the use of a chelating agent is the determination of water hardness by the reaction of disodium dihydrogen ethylenediamine tetraacetate (EDTA or versene) with calcium and magnesium in water. The EDTA ligand is an extraordinarily good chelating agent and can bond to metal ions in up to six sites. It forms extremely stable metal chelates.

The ability of chelating agents to drastically reduce the concentration of "free" metal ions in water is one of their most important effects. For example, if EDTA is present in water, calcium in the water may be tied up in the form of an EDTA chelate and therefore may not be available for scale formation.

The possible effects of chelating agents in natural waters and wastewaters are numerous.

Manka, J., M. Rebhun, A. Mandelbaum, and A. Bortinger.

Characterization of Organics in Secondary Effluents.

Environmental Science and Technology. 8(12):1017-1019. November 1974.

Key Words: synthetic/organics, effluent characteristics.

Abstract:

The composition of soluble organics in secondary effluents from various treatment plants has been investigated. On the whole, the results obtained were repeatable within a relatively low degree of deviation. Gel permeation chromatography reveals that the majority of the humic compounds isolated from the secondary effluents are within a molecular weight range of 1000-5000. The acidic functional groups of those compounds are mostly carboxylic with a small percentage of phenylhydroxyls. A number of specific compounds have been identified within the fraction of ether extractables, by using mass spectrometer coupled with gas chromatograph.

Manske, D.D. and P.E. Corneliussen.

Pesticide Residues in Total Diet Samples (VII).

Pesticides Monitoring Journal. 8(2):110-124. September 1974.

Key Words: dieldrin, cadmium, DDT, DDD, chlorinated hydrocarbons, organophosphorous pesticides, livestock.

Abstract:

Pesticide residue levels detected in ready-to-eat foods remained at relatively low levels during the seventh year of the Total Diet Study in its present form. Samples were collected from 30 markets in 27 different cities. Populations of cities ranged from less than 50,000 to 1,000,000 or more. Averages and ranges of pesticides commonly found are reported for the period June 1970-April 1971 by region and food class. Pesticides found infrequently are also reported for this period by region and food class. Results of recovery studies with various classes of pesticides are also presented. After October 1970, analyses of bromides, amitrole, and dithiocarbamates were discontinued; mercury and orthophenylphenol were added. Residue levels in three major fatty food groups are now reported on a whole-product basis, rather than on a fat basis. Data for June and August were adjusted accordingly.

Manson, R.J. and C.A. Merritt.

Land Application of Liquid Municipal Wastewater Sludges.

JWPCF. 47(1):20-29. January 1975.

Key Words: cadmium, chromium, copper, nickel, zinc, agriculture.

Abstract:

The advantages of a direct land application program may be summarized as follows:

1. Money invested in land is never lost.

2. The return on the sale of the sludge-fertilized crops helps pay for the entire operation.

3. It is a true disposal method as well as a method of resource recovery.

4. It is a simple and straighforward method in comparison with most methods presently in use.

5. Equipment and operating costs are low.

6. This method is highly flexible, both in application techniques and in the types of crops that may be grown.

7. It has little environmental impact.

Manwaring, J.F.

Removal of Viruses by Coagulation and Flocculation.

JAWWA. 63(5):298-300. May 1971.

Key Words: viruses, chemical treatment.

Abstract;

The laboratory studies on coagulation and flocculation, using a bacterial virus and ferric chloride as the coagulant reported herein, lead to the following conclusions:

1. Chemical coagulation and flocculation with ferric chloride is as effective as that with aluminum sulfate in removing viruses from water.

2. Calcium and magnesium, up to a concentration of 50 mg/l each, were found not to interfere with the efficiency of the process.

3. Chemical coagulation and flocculation cannot be expected to operate with a high degree of efficiency in terms of virus removal when the raw water contains organic matter.

4. Virus particles remain "active" in the settled sludge following their removal from water by coagulation and flocculation, and can be recovered from the floc by various eluants. Therefore, proper care should be taken in the disposal of sludge from coagulation-flocculation operations.

Mara, D.D.

Fecal Bacterial Kinetics in Stabilization Ponds.

Journal of the Environmental Engineering Division, ASCE.
100(EE5):1191-1192. October 1974.

Key Words: fecal streptococci, coliforms, ponding/land application.

Abstract:
There is a reduction of 72-80% of fecal bacteria in anaerobic ponds with a retention time of two days as reported in this article.

Marais, G.v.R.

Faecal Bacterial Kinetics in Stabilization Ponds.

Journal of the Environmental Engineering Division, ASCE. 100(EE1):119-139. February 1974.

Key Words: *Escherichia coli*, fecal streptococci, coliforms, ponding/land application.

Abstract:

The following conclusions were reached:

1. Die-off of faecal organisms *E. coli*, F. Strep., and and total coliforms in a pond is according to Chick's Law, i.e., $dN/dt = -KN$.

2. In a completely mixed pond the steady state concentration, N, is given by $N = N_0/(KR + 1)$, in which R = the retention time based on influent flow.

3. In a series of ponds, the effluent quality from the nth pond in the series is given by: $N_n = N_0/[(KR_1 + 1)(KR_2 + 1)...(KR_n + 1)]$.

4. In plug flow conditions, the effluent quality is given by: $N = N_0e^{-Kt}$.

5. Per unit of retention time the plug flow system is the most efficient, the series pond system intermediate, and a single pond the least efficient. The efficiency of the series increases as the number of ponds increase for a fixed total retention time. From practical considerations, up to 90% reduction a single pond is normally adequate, up to 99% - two ponds in series, up to 99.9% - three ponds in series, etc. Plug flow conditions are difficult to achieve so that the series system is the most practical.

6. Maximum efficiency in a series system is achieved by making the retention times of all the ponds equal.

7. Recycling from a secondary pond to the first pond in a series decreases the efficiency of the system.

8. The rate constant, K, is very sensitive to temperature, and approximately related as follows: $K_T = 2.6(1.19)^{T-20}$; (T^oC). This relationship presumes the ponds are mixed and aerobic or facultative and is valid between approximately 5^oC-21^oC.

9. Above approximately 21^oC, with low wind velocities,

periods of stratification occur and the lower liquid depth of a pond turns anaerobic. Anaerobic conditions cause a decline in the value of K so that the reduction of faecal organisms is sharply reduced.

10. When winter temperatures are very low, so that K is very small, series operation will yield relatively minor improvement over single pond operation.

Markin, G.P., J.C. Hawthorne, H.L. Collins, and J.H. Ford.

Levels of Mirex and Some Other Organochlorine Residues in Seafood from Atlantic and Gulf Coastal States.

Pesticides Monitoring Journal. 7:139-143. March 1974.

Key Words: DDT, DDE, chlorinated hydrocarbons, fish, shellfish.

Abstract:

A seafood monitoring program for the insecticide mirex was set up in 1971. Seventy-seven composite samples of oysters, crabs, shrimp, fish, and fish products were collected from seven locations within the area where mirex is used and from two check locations outside the treatment areas. The study showed that mirex occurred in only nine of the 77 samples (0.005-0.024 ppm range), all from near Savannah, Georgia. DDT or its metabolites occurred in 74 samples (0.002-2.475 ppm range). The polychlorinated byphenyl (PCB) Aroclor 1260 occurred in 46 samples; if extensive new methods of cleanup had not been used, these PCB residues probably would have been interpreted as mirex. Several early studies reporting extensive residues of mirex in marine life were made before the possibility of confusing Aroclor 1260 with mirex had been realized; hence these earlier studies may be in error.

Martin, D.F. and B.B. Martin.

Implications of Metal-Organic Compounds in Red Tide Outbreaks.

In: Trace Metals and Metal-Organic Interactions in Natural Waters, P.C. Singer, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1974. pp. 339-362.

Key Words: iron, direct contact, surface water (fresh), groundwater.

Abstract:

The parameter intensity was low in late spring, increased to a maximum in late summer, decreased to a minimum in winter, then increased in spring. (A similar pattern for humic acid was observed in subsequent years. A similar, though less intense, pattern was observed for a group of three west central streams (Anclote, Withlacoochee, Suwannee) and for a group of six northwest streams (Steinhatchee, Econfina, Aucilla, St. Marks, Ochlockonee, and Apalachicola).

The southwestern rivers were characterized by uniformly high concentrations of humic acids, west central by intermediate concentrations and northwestern rivers by uniformly low concentrations. The data indicate that, because of the effect of high flow rates, northwestern streams deliver more humic acid to a potential outbreak. This observation and the apparent colloidal nature of humic acids would account for extensive humate beds and humate-impregnated sands in northwestern Florida. The observations might also suggest that concentration, not total amount of humic acid and/or selected trace elements, should be significant in accounting for red tide outbreaks.

In part, the answer emerged from a study of selected metal-chelate inputs of 14 west coast Florida streams during 1968-1969. Water samples were analyzed for humic acid concentration, as well as concentration of particulate and soluble forms of iron, copper, manganese and zinc. An association between humic, iron concentration and rainfall emerged.

Details are given, and only the salient features are reviewed here.

Temporal and spatial variations of three parameters -- iron and humic acid concentrations and rainfall -- followed a common pattern for a group of five southwestern rivers (Hillsborough, Manatee, Myakka, Peace, Caloosahatchee).

Martin, R.

Determination of Heavy Metals in Digested Sewage Sludge.

Personal communication, 1975.

Key Words: copper, chromium, cadmium, lead, zinc, crops.

Abstract:

The nitric acid-perchloric acid digestion appears to be the best of the two techniques for recovery of the heavy metals studied in this work. The concentration of the metals studied are in the ranges reported in the literature surveyed.

Martin, R.

The Determination of Heavy Metals in Soil Treated with Digested Sewage Sludges.

Personal communication, 1975.

Key Words: cadmium, chromium, copper, lead, zinc, crops.

Abstract:

The author analyzed the soils in two geographically and geologically similar fields to determine the effects of heavy metals in the digested sludge which had been spread on the soil and grasses of the pasture lands. He concluded that such an analysis can provide useful data for determining the uses to which soils so treated can be put.

Maruyama, T., S.A. Hannah, and J.M. Cohen.

Metal Removal by Physical and Chemical Treatment Processes.

JWPCF. 47:962-975. May 1975.

Key Words: manganese, nickel, zinc, copper, cadmium, barium, lead, chromium, arsenic, mercury, chemical treatment, adsorption/ion exchange.

Abstract:

This is an excellent publication on the operation of a coagulation-flocculation-carbon column pilot plant at the EPA Advanced Waste Treatment Research Laboratory.

Marx, J.L.

Drinking Water: Another Source of Carcinogens.

Science. 86:809-811. November 1974.

Key Words: pesticides, synthetic/organics, surface water (fresh).

Abstract:

This is a general discussion on the carcinogenity of a water supply and the difficulties in cancer research.

Mason, J.O. and W.R. McLean.

Infectious Hepatitis Traced to the Consumption of Raw Oysters.

American Journal of Hygiene. 75:90-111. 1962.

Key Words: hepatitis virus, shellfish, epidemiology.

Abstract:

In this article the authors describe in detail an outbreak of infectious hepatitis in the cities and surrounding county areas of Pascagoula, Mississippi, and Mobile and Troy, Alabama. This is the first report relating the spread of the disease in the United States to the consumption of raw oysters.

Matches, J.R., J. Liston, and P. Curran.

Clostridium perfringens in the Environment.

Applied Microbiology. 28:655-660. October 1974.

Key Words: Clostridium welchi, surface water (marine).

Abstract:

Clostridium perfringens was isolated from samples collected in Puget Sound in the state of Washington and areas considered as possible sources of these organisms to Puget Sound. The distribution of C. perfringens in the total clostridium population was determined for fish gut contents and sediments collected in highly polluted and less polluted areas, sewage samples, freshwater sediments, and soils. The greatest numbers of C. perfringens were obtained from marine sediments collected near the sewage outfall at West Point. Fewer isolates were made from fish collected from less polluted stations, although the number of C. perfringens remained high in sediments from other Puget Sound stations. The proportion of C. perfringens in the total clostridium populations varied between 56 and 71% for sewage samples and only 0.4 to 4.1% for freshwater sediments and soil samples. Only 25 C. perfringens isolates out of 137 from fish guts, or 18%, were identifiable serologically and these fell into 12 groups. C. perfringens were fed to fish and the fish were sacrificed after varying lengths of time. The number of C. perfringens increased slightly in the gut during the first 24 hr and then the numbers decreased rapidly for the next 120 hr.

Mathis, B.J. and T.F. Cummings.

Selected Metals in Sediments, Water, and Biota in the Illinois River.

JWPCF. 45(7):1573-1583. July 1973.

Key Words: copper, nickel, lead, chromium, zinc, cobalt, cadmium, surface water (fresh), fish, shellfish.

Abstract:

The bottom-dwelling tubificids and clams closely reflected the concentrations of metals found in bottom sediments. A concentration gradient ranging from highest levels in worms, intermediate levels in clams, and lowest levels in fish fillets was observed for copper, nickel, lead, chromium, lithium, cobalt, and cadmium. Zinc, however, exhibited a partial reversal of this trend. It was present in highest concentrations in clams, at intermediate levels in worms, and at lowest levels in fish fillets.

With the exception of copper in worms, metals were more highly concentrated in bottom sediments. The water component of the river exhibited the lowest concentration of metals with the exception of lithium.

Mathur, R.P and N.S. Grenwal.

Underground Travel of Pollutants.

In: Advances in Wastewater Research, Pergamon Press, New York. B/15/30/1-8. 1972.

Key Words: bacteria, groundwater.

Abstract:

The present investigation is an attempt to study how wastewater is likely to travel after its introduction into the groundwater. A model study of dispersion of organic matter in the form of synthetic sewage has been made. The parameters selected were organic matter (oxygen consumed by the $KMnO_4$ test) and the Enterococcus group of bacteria.

Matsumura, F., Y. Gotoh, and G.M. Boush.

Factors Influencing Translocation and Transformation of Mercury in River Sediment.

Bulletin of Environmental Contamination and Toxicology. 8(5):267-272. November 1972.

Key Words: mercury, surface water (fresh).

Abstract:

Three factors contribute to the release of mercury into water: alkaline pH, the organic content of sediments, and microorganisms. Such processes are not necessarily directly related to methylmercury formation. The significance of such release is not certain.

Mattson, J.S. and F.W. Kennedy.

Evaluation Criteria for Granular Activated Carbons.

JWPCF. 43(11):2210-2217. November 1971.

Key Words: synthetic/organics, adsorption/ion exchange.

Abstract:

The technical evaluation of activated carbons would benefit from the addition of procedures for the determination of adsorption rate and capacity, as well as a determination of the ability of each carbon to withstand a specified level of mechanical attrition. By judicious selection of a material based on these criteria, as well as the price, of course, the operating costs of physical-chemical and tertiary treatment may be reduced by a significant amount.

Maxwell, K.E.

Environment of Life.

Dickenson Publishing Company, Encino, Calif., 1976. 418p.

Key Word: epidemiology.

Abstract:

This is a book whose overall purpose and thrust are primarily informative and authoritative; it will serve as useful background for the environment and its biological impact.

The contents include: the nature of the environment (including their major components), environmental quality (air pollution, water pollution, pesticides, etc.), food quality, the internal and external environment (including genetic injury, mutations, somatic injury, radiation), and populations.

Mayrose, D.F.

Heat Treatment and Incineration.

In: Municipal Sludge Management; Proceedings of the National Conference on Municipal Sludge Management, June 11-13, 1974. pp. 87-91.

Key Words: BOD, heat treatment, activated sludge.

Abstract:

Heat treatment of sewage sludges does produce liquors high in soluble BOD. This is due to the so-called hydrolyzation that takes place and also to the leaching of the cell water from the structure during heat treatment. In those plants in which primary plus waste activated sludges are heat treated, the recycled heat treatment liquor contains a dissolved BOD load approximately equal to 25 percent of the primary settled sewage.

McAchran, G.E. and R.D. Hogue.

Phosphate Removal from Municipal Sewage.

Water and Sewage Works. 118(2):36-39. February 1971.

Key Words: phosphates, chemical treatment.

Abstract:

A detailed and extensive set of phosphorus concentration and removal data has been determined on an operating biological sewage treatment plant. The data show extensive weekly, daily and hourly variations in the influent phosphorus concentration. Such variations emphasize the danger of conclusions based on grab samples or samples taken over a brief time interval.

Based on the data, aluminum sulfate and sodium aluminate are equally effective for phosphate removal at equal Al/P mole ratios.

It is difficult to judge whether the 5 percent additional phosphate removal obtained by programmed precipitant addition is statistically significant or not. However, it is felt that the technique merits additional study.

McCann, J. and B.N. Ames.

Detection of Carcinogens as Mutagens in the Salmonella/ Microsome Test: Assay of 300 Chemicals: Discussion.

Proceedings National Academy of Sciences. 73(3):950-954. March 1976.

Key Words: salmonella, epidemiology.

Abstract:

Of the 300 chemicals tested, there is a high correlation between carcinogenicity and mutagenicity (90%).

McCann, J., E. Choi, E. Yamasaki, and B.N. Ames.

Detection of Carcinogens as Mutagens in Salmonella/Microsome Test: Assay of 300 Chemicals.

Proceedings National Academy of Sciences. 72(12):5135-5139. December 1975.

Key Words: salmonella, epidemiology.

Abstract:

Salmonella was used for 300 chemicals as sensitive indicators for DNA damage, and mammalian liver extracts were studied for metabolic conversion of carcinogens to their active mutagenic forms.

McCarthy, J.J. and C.H. Smith.

A Review of Ozone and Its Application to Domestic Wastewater Treatment.

JAWWA. 66:718-725. December 1974.

Key Words: BOD, ozonation.

Abstract:

This paper discusses generalities concerning ozonation. No relevant data appear.

McCarty, P.L.

Biological Processes for Nitrogen Removal - Theory and Application.

Proceedings Twelfth Sanitary Engineering Conference; Nitrate and Water Supply: Source and Control. University of Illinois, February 1970. pp. 136-152.

Key Words: ammonia, nitrates, nitrites, nitrification/denitrification.

Abstract:

Nitrogen can be removed biologically from wastewater by three different processes: bacterial assimilation, algae harvesting, and nitrification/denitrification. Through bacterial assimilation, nitrogen is converted into bacterial protoplasm which is then removed in a subsequent phase separation process. Nitrogen removal through bacterial assimilation is a function of the quantity of wastewater being treated and the growth yield of the micro-organisms. In the biological treatment of most wastewaters a certain degree of nitrogen removal is attained; however, this result is dependent on the amount of nitrogen available relative to the organic matter present. The maximum efficiency of this process is apparently feasible only when nitrogen is not in excess (at a BOD_L to nitrogen ratio of about 20/1).

Nitrogen removal by algal harvesting involves use of solar radiation to convert inorganic nitrogen to cell protein. The efficiency of this conversion is a function of the production rate of algae and the nitrogen content of the cells, while the rate of growth of the algal cells is dependent on light availability, retention time, and relative concentrations of essential nutrients.

Bacterial nitrification-denitrification is perhaps the most promising of the processes. Ammonia nitrogen removal is the result of two stages. In nitrification, ammonia-nitrogen is converted to nitrate-nitrogen by two different groups of autotrophic nitrifying bacteria. Denitrification is the reduction of nitrates and nitrites to nitrogen gas by a wide variety of facultative bacteria under anaerobic conditions. An additional organic source is necessary for efficient conversion to nitrogen gas, and methanol appears to be the least expensive. Studies of the nitrification-denitrification process at Firebaugh, California are discussed.

In general for agricultural and domestic wastewater, costs for nitrogen removal may range from 2 to 10 cents per 1,000 gallons. Of the three processes considered, nitrification-denitrification is perhaps the most generally applicable because of good reliability, suitability to a variety of conditions, low area requirements and moderate cost.

McDermott, D.J.

Characteristics of Municipal Wastewaters, 1971 to 1973.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1974. pp. 89-96.

Key Words: suspended solids, BOD, COD, oil and grease, nitrates, ammonia, cyanides, synthetic/organics, phosphates, arsenic, cadmium, chromium, copper, iron, mercury, manganese, zinc, lead, selenium, effluent characteristics.

Abstract:

This is a comparison of municipal effluent data on a yearly basis.

McDermott, D.J. and T.C. Heesen.

DDT and PCB in Dover Sole around Outfalls.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1975. pp. 117-121.

Key Words: DDT, chlorinated hydrocarbons, fish.

Abstract:
This paper compares levels of DDT and PCB's in two separate studies (1971-72 & 1974-75).

McDermott, D.J. and T.C. Heesen.

Inventory of DDT in Sediments.

Southern California Water Research Project. Annual Report. El Segundo, Ca., June 30, 1974. pp. 123-127.

Key Words: DDT, surface water (marine).

Abstract:

This paper compares levels of DDT in sediments off five major municipal wastewater outfall systems in southern California.

McDermott, D.J. and L.R. Young.

Trace Metals in Flatfish around Outfalls.

Southern California Coastal Waters Research Project. Annual Report. El Segundo, Ca., June 30, 1975. pp. 117-121.

Key Words: cadmium, chromium, copper, lead, zinc, fish.

Abstract:
This article discusses levels of metals in marine fish off the coast of southern California.

McDermott, D.J., T.C. Heesen, and D.R. Young.

DDT in Bottom Sediments around Five Southern California Outfall Systems.

Southern California Coastal Water Research Project. El Segundo, Ca., December 1974. 54p.

Key Words: DDT, surface water (fresh), surface water (marine), shellfish. fish.

Abstract:

The pesticide DDT appears to be one of the most serious contaminants yet described in the Southern California Bight. Levels of this chlorinated hydrocarbon and its metabolites in sandcrabs and intertidal mussels taken off Palos Verdes Peninsula in the early 1970's were 50 to 100 times higher than concentrations found 200 km to the north and south. In addition, approximately two-thirds of the Dover sole trawled off the Peninsula during 1971-72 were found to contain muscle concentrations exceeding the 5-ppm limit for seafood intended for interstate commerce set by the U.S. Food and Drug Administration. Such DDT gradients are attributed to long-term discharges of this pesticide via the submarine municipal wastewater outfalls of the County Sanitation Districts of Los Angeles County off Whites Point. Approximately 19,000 kg/yr total DDT were discharged through this system in 1971, and although the amount had been reduced to approximately 3,000 kg/yr in 1973, the outfall system is still the dominant known source of DDT to the Bight.

Trace constituents such as heavy metals and chlorinated hydrocarbons are found to be largely associated with particulate matter in wastewaters. Therefore, the sediments in the receiving environment may be an important reservoir of these contaminants. To investigate this possibility, the Coastal Water Research Project conducted a survey of DDT compounds in ocean bottom sediments collected around the major municipal wastewater discharge systems in the Bight: The data obtained from these studies are reported here, and the results are briefly evaluated.

McDermott, G.N., W.A. Moore, M.A. Post, and M.B. Ettinger.

Effects of Copper on Aerobic Biological Sewage Treatment.

JWPCF. 35(2):227-241. February 1963.

Key Words: copper, BOD, activated sludge.

Abstract:

Copper continuously present in concentrations ranging from 0.4 to 25 mg/l in the raw sewage entering a complete pilot activated sludge treatment plant reduced BOD removal efficiency zero to seven percent, roughly in proportion to metal concentration, after the plant became acclimated to the metal. Two forms of copper, copper sulphate and copper cyanide complex, had about the same effects after the system had become acclimated. The process was 50- to 79-percent efficient in removal of copper. From about 25 to 75 percent of the copper in the final effluent was in solution.

Four-hour slug doses of copper as copper sulphate in concentrations greater than 50 mg/l had severe effects on the efficiency of an unacclimated system. The system returned to normal in about 100 hr. Slugs of copper cyanide complex had much more severe maximum effects, but the system returned to normal in about 24 hr. Copper in slug doses of copper sulphate is largely adsorbed by the activated sludge and slowly released, whereas copper cyanide slugs pass through the system in normal detention times.

The maximum concentration of copper that does not have a detectable effect on treatment efficiency is concluded to be 1 mg/l. Slug doses of a few hours duration with up to 50-mg/l copper as copper sulphate or 10-mg/l copper as copper cyanide complex have but a slight effect on treatment efficiency.

McDermott, G.N., M.A. Post, B.N. Jackson, and M.B. Ettinger.

Nickel in Relation to Activated Sludge and Anaerobic Digestion Process.

JWPCF. 37(2):163-177. February 1965.

Key Words: nickel, BOD, COD, activated sludge, anaerobic digestion, effluent characteristics.

Abstract:

Nickel, present continuously in concentrations ranging from 2.5 to 10 mg/l in the sewage entering a complete activated sludge pilot plant, reduced the BOD removal efficiency a maximum of about 5 percent. Increased turbidity in the final effluent is the most objectionable feature. The maximum level of nickel which will not produce a detectable effect on treatment efficiency was indicated as being greater than 1 mg/l and less than 2.5 mg/l.

A 200-mg/l slug dose of nickel caused a serious reduction in treatment efficiency for a few hours, but the plant returned to normal performance within 40 hr.

Combined primary and excess activated sludge from a plant receiving 10 mg of nickel per liter, continuously, digested satisfactorily. Primary sludge, from sewage containing 10 mg/l of nickel, digested satisfactorily.

A small percentage of nickel is removed in primary settling. The complete activated sludge process is about 30-percent efficient in removing nickel. The sulfide content of the influent sewage has no correlation with efficiency of nickel removal.

McDermott, J.H.

Virus Problems in Water Supplies. Part II.

Water and Sewage Works. 122(6):76-77. September 1975.

Key Words: viruses, surface water (fresh), surface water (marine), drinking and recreational water.

Abstract:

This article discusses the virus problem in water supplies and possible solutions to the problem.

McGarry, M.G.

Algal Flocculation with Aluminum Sulfate and Polyelectrolytes.

JWPCF. 42(5):R191-R201. May 1970.

Key Words: BOD, chemical treatment.

Abstract:

The high-rate pond process is being developed to treat wastewater and to provide a new source of edible protein in the form of algae. Chemical flocculation was studied as a means of harvesting the dispersed algae from heavily-laden pond water. Aluminum sulfate was tested as a primary coagulant and in conjunction with a variety of polyelectrolytes. The independent variables studied were alum and polyelectrolyte concentrations, time of polyelectrolyte addition, fast- and slow-mixing period, and degree of turbulence. A detailed experiment was performed to compare the four most promising polyelectrolytes in combination with alum.

McGinnes, P.R. and V.L. Snoeyink.

Determination of the Fate of Polynuclear Aromatic Hydrocarbons in Natural Water Systems.

University of Illinois, Urbana, Water Resources Center, March 1974. 62p. (Available from National Technical Information Service (NTIS) as PB-232 168).

Key Words: synthetic/organics, surface water (fresh), direct contact, surface water (marine).

Abstract:

The polynuclear aromatic hydrocarbons, or PAH, are of current concern as water pollutants and potential health hazards. The presence of PAH in natural water systems was evaluated and an analytical technique for specific PAH was developed. It was found that the PAH are not soluble in water but they either are present as particulate material or as material absorbed on solid surfaces in natural water systems. The photodecomposition of two PAH, 1,2 benzanthracene, or BA, and 3,4 benzpyrene, or BP, was examined. This decomposition is relatively unaffected by water chemistry and will occur under solar radiation and in turbid waters.

McGregor, W.C. and R.K. Finn.

Factors Affecting the Flocculation of Bacteria by Chemical Additives.

Biotechnology and Bioengineering. 11(2):127-138. March 1969.

Key Words: Escherichia coli, chemical treatment.

Abstract:

Pure bacterial cultures can be flocculated by a variety of chemical flocculants. Flocculation of bacteria will assist in their recovery, especially where the cells themselves are of interest, as in microbial protein production. Studies with several genera of bacteria indicate that the mechanism of flocculation is highly complex. Such interacting variables as temperature, ionic environment, physiological age, flocculant, bacterial genus, and surface shear have been observed. Jar test experiments with washed cells indicate that many of the variables are related to the release by the cell of proteins, nucleic acids, or polysaccharides. When released, these polymers may increase the required dosage of flocculant for recovery as in the case of *E. coli*, or the dosage may decrease as it does for lactobacillus.

McGuire, J.H., A.L. Alford, and M.H. Carter.

Organic Pollutant Identification Utilizing Mass Spectrometry.

U.S. Environmental Protection Agency, Southeast Environmental Research Laboratory, Athens, Ga., July 1973. 51p. (Available from National Technical Information Service (NTIS) as PB-224 544).

Key Words: synthetic/organics, influent characteristics, effluent characteristics.

Abstract:

A system has been developed for the rapid identification of volatile organic water pollutants. It involves computer controlled gas chromatography/mass spectrometry with computerized matching of mass spectra. Application of this system to the analysis of waste effluents revealed a significant number of pollutants that were not previously known to be present.

McKee, G.D., L.P. Parrish, C.R. Hirth, K.M. Mackenthun, and L.E. Keup.

Sediment-Water Nutrient Relationships. Part 1.

Water and Sewage Works. 117(6):203-206. June 1970.

Key Words: phosphates, nitrates, surface water (marine), surface water (fresh).

Abstract:

The bed of a water body must be considered an integral part of the aquatic system. The role of sediments varies with their composition, the amount of mixing with the water, and biological transformations which occur between the sediments and the water. Sediments may only serve to support the water, or they may have a profound effect on the quality of that water which comes into contact with them.

In a lake which man has not polluted seriously, and which has not received large amounts of land runoff, the bed will resemble the soils of the surrounding land. As man "civilized" an area by plowing fertilized fields and discharging sewage and industrial wastes to the water, the sediments assumed different characteristics due to the materials that became a part of them. Materials present in the sediments became more numerous, the soil chemistry more complex, and biological populations became more numerous and complex. Sediments began to reflect man's influence on the entire water system.

McKee, G.D., L.P. Parrish, C.R. Hirth, K.M. Mackenthun, and L.E. Keup.

Sediment-Water Nutrient Relationships. Part 2.

Water and Sewage Works. 117(7):246-249. July 1970.

Key Words: phosphates, nitrates, surface water (marine), surface water (fresh).

Abstract:

This is a good review on the role of sediments in water quality.

McKee, J.E., C.J. Brokaw, and R.T. McLaughlin.

Chemical and Colicidal Effects of Halogens in Sewage.

JWPCF. 32(8):795-819. August 1960.

Key Words: chlorination, disinfection.

Abstract:

This article is a good general discussion on the chemistry of chlorine, bromine, and iodine in water, including a discussion of residuals.

McKendrick, J., G.R. Bates, and E.R. Swart.

The Physico-Chemical Treatment of Crude Sewage.

Water Pollution Control. 74(2):155-159. 1975.

Key Words: chlorides, ammonia, BOD, COD, nitrates, phosphates, chemical treatment, filtration, nitrification/dentrification, adsorption/ion exchange.

Abstract:

Results of a physical-chemical treatment pilot plant study are given in terms of removal efficiencies for general parameters.

McLaren, R.G. and D.V. Crawford.

The Fractionation of Copper in Soils.

Journal of Soil Science. 24:172-181. February 1973.

Key Words: copper, direct contact, groundwater.

Abstract:

A method for fractionating soil copper was developed and applied to 24 soils representing a range of British soil types.

The scheme distinguishes five fractions:

(a) soil solution and exchangeable copper;
(b) copper weakly bound to specific sites;
(c) organically bound copper;
(d) copper occluded by oxide material; and
(e) residual copper mainly in clay lattice structures.

Correlation and regression analyses confirmed the general validity of the scheme and indicated an association between free manganese oxides and copper which considerably influences the distribution of copper between the main soil constituents. It is suggested that the concentration of copper in the soil solution is controlled by equilibria involving specifically adsorbed copper and that the bulk of the available soil copper reserves reside in the organically bound fraction.

McLean, D.

Sewage Irrigation Health Benefit or Hazard?

Annals of Internal Medicine. 82(1):112-113. January 1975.

Key Word: epidemiology.

Abstract:

The previous month's editorial by Stewart Udall and Jeff Stansbury urged wider use of sewage irrigation to reduce disposal costs and conserve plant nutrients and water.

This editorial article looks at possible microbiologic risks.

McLean, D.M.

Transmission of Viral Infections by Recreational Water.

In: Transmission of Viruses by the Water Route. G. Berg, ed. Wiley, New York, 1965. pp. 25-35.

Key Words: viruses, polio virus, drinking and recreational water.

Abstract:

Prolonged persistence of a representative test virus, the attenuated Sabin strain of poliovirus 2, in natural waters in the absence of agitation, but its rapid dilution to non-infective levels in moving water, together with an accelerated loss of infectivity in swimming pool water which contained halogens, illustrate clearly the significance both of dilution and virucidal agents in minimizing the importance of recreational waters as sources of viral infection for bathers.

Although no virus has yet been isolated from numerous grab samples of water collected from lakes and creeks used for recreational purposes in southern Ontario between 1962 and 1964, most collection points were remote from sewer outfalls or other continuous sources of viral pollution. Even when a prevailing westerly wind promoted the flow of effluent towards a bathing beach along Lake Ontario from a sewage treatment plant located 1 mile distant, as shown by increase of coliform indices, no virus was isolated from these water samples, possibly on account of the vast dilution factor in lake water. However, enteroviruses or reoviruses were isolated from swabs immersed in terminal branches of the Upper Illinois River near Chicago during the summer of 1962, on 6 of 37 occasions at points 1 mile upstream from sewage treatment plants, and on 13 of 34 occasions at points 1 mile below the sewer outfall. Sewage effluents from these three activated sludge treatment plants yielded viruses on 23 of 44 occasions. The absence of continuous dilution of sewage effluent in these stagnant river branches, as shown by the isolation of viruses upstream and downstream of the sewer outfalls, permitted the accumulation of enteric viruses throughout summer, in contradistinction to Lake Ontario in the vicinity of a sewage treatment plant. The prevalence of enteroviruses in activated sludge effluent from a Santee, California, sewage treatment plant between March and December 1962, declined from 100 to 22% following holding in an oxidation pond for an average duration of 30 days. A further decline to a 10% rate of virus isolation was found after treatment of effluent from the oxidation pond with 15 mg/liter of

chlorine for 30 min, and no viruses were detected in water which entered a lake used for recreational purposes after the chlorinated effluent had percolated through natural sand and gravel 10 to 12 ft thick. Although 97.7% of 43 activated sludge effluents and 100% of influents yielded virus, reduction of plaque counts by 76 to 90% in effluents suggest that a substantial degree of viral inactivation has occurred during sludge treatment. These results demonstrate the desirability of treating sewage by a sequence of holding in an oxidation pond, treatment with chlorine and percolation through sand before the effluent is released into natural bodies of water.

The association of swimming pools with human infections by adenovirus 3 was first demonstrated in Washington, D.C., during summer 1954, and subsequently in Toronto during 1955. The outbreak of febrile vesicular exanthem among 27 families living in a Toronto suburb during the summer 1957 was probably facilitated by the extensive use of backyard swimming pools by children. Maintenance of adequate levels of chlorine or other halogens as disinfectants in both public and private swimming pools, the rare occasions on which viruses have been isolated from Toronto swimming pools and the absence of reports of pharyngoconjunctival fever or other illnesses following use of swimming pools within recent years, confirm experimental findings reported above that halogens together with adequate water circulation are satisfactory mechanisms for removal of viral infection hazards from swimming pools.

McLean, D.M. and J.R. Brown.

Marine and Freshwater Virus Dispersal.

Canadian Journal of Public Health. 59(3):100-104. 1968.

Key Words: viruses, polio virus, drinking and recreational water.

Abstract:

Sabin poliovirus 2 persisted at undiminished titre in freshwater for 12 days at 4°C, but the infectivity declined one hundred fold in seawater over this period at 4°C, and was undetected after being held in seawater for 5 days at 25°C.

Virus infectivity persisted at beaches and in open water for 5 to 10 minutes both in seawater and freshwater. Virus was recovered after 65 feet of lateral drift at a freshwater beach, and after 25 feet of drift at a sea beach. Virus dispersal was relatively unaffected by wave actions.

Virus inactivation occurred in the presence of adequate mixing following addition of high residuals of free chlorine to creeks which were loaded with virus pulses.

McLean, D.M., J.R. Brown, and R. Laak.

Virus Dispersal by Water.

JAWWA. 58(7):920-928. July 1966.

Key Words: hepatitis virus, viruses, polio virus, coxsackie virus, surface water (fresh), activated sludge, chlorination.

Abstract:

The progressive decline of virus titer in creek water at points downstream from the sites of addition of attenuated poliovirus-2 to three creeks, and the lengthened duration of detection of virus following its addition continuously in contrast to pulses, indicate that the flow of water exerts a sustained dilution action, thereby reducing the potentials of these creeks as hazards of infection; however, continuous addition of virus over a prolonged period, for example infectious hepatitis virus in unchlorinated sewage effluent, into a slowly moving river increased the hazard of infection to such an extent that six of nineteen subjects at Bathurst, Australia contracted infectious hepatitis after drinking river water contaminated by sewage. Similarly, slowing of water movement to stagnation point in the upper Illinois River near Chicago, permitted the accumulation of enteroviruses both upstream and downstream from sewer outfalls.

The relatively prolonged persistence of attenuated poliovirus-3 in an aeration tank up to 6 days following addition of a virus pulse to a tank with continuous flow operation, and the slow decline of infective titers during this period in the current experiment contrast with the virtually complete inactivation of Coxsackie virus A9 some 6 hr after addition to activated sludge in a stationary aeration tank. When Coxsackie virus A9 and poliovirus were added continuously during a period of 48 hr to a bench model activated sludge unit the infectivity of the effluent was reduced by 96.1 to 99.4 percent and 79 to 94 percent for the two viruses, respectively. Despite this reduction of infective titer, substantial concentrations of virus remained in the effluent. Furthermore, Coxsackie virus A13 was recovered repeatedly from effluent following aeration treatment. Similarly at the Santee, California, sewage treatment plant, activated sludge treatment failed to remove enteroviruses present in city sewage, although the infective titers of viruses in the effluent were 76-90 percent lower than those in the influent.

Filtration of activated sludge effluent through sand effected a greater reduction of Coxsackie virus A13 infectivity than passage through a trickling filter, but chlorination of filtrates with a residual of 0.5 ppm for a contact time of 8 hr was required to inactivate virus completely. The present results showed that poliovirus-3 was not eliminated by filtration through columns of sand or soil, but the slow diminution of virus titers in successive daily samples of effluent appeared to result mainly from dilution together with continuous flowing of liquid through the columns.

McLellon, M., T.M. Kunath, and C. Chao.

Coagulation of Colloidal- and Solution-Phase Impurities in Trickling Filter Effluents.

JWPCF. 44(1):77-91. January 1972.

Key Words: COD, bacteria, ammonia, nitrates, nitrites, phosphates, trickling filter, chemical treatment.

Abstract:

The results of this research investigation demonstrate that chemical coagulation with salts of Fe^{3+} and Al^{3+} can complement and substantially enhance the treatment efficiencies of existing wastewater treatment facilities. In this manner secondary wastewater treatment plants can be upgraded to the extent that the water quality standards applicable to the receiving waters can be maintained with minimal expenditures of capital. Further, because coagulation is a process of high operating and low capital costs and because it can be placed on line instantaneously and can be controlled easily, it is particularly suited for application to certain wastewater treatment facilities that require high levels of treatment during occasional critical periods during which water quality standards cannot generally be met.

McMichael, F.C. and J.E. McKee.

Wastewater Reclamation at Whittier Narrows, California.

California Institute of Technology , Pasadena, September 1965, 116p.

Key Words: activated sludge, groundwater, effluent characteristics.

Abstract:

The general objective of this study was to determine the effects of intermittent percolation through soil of highly treated activated sludge effluent on the quality of groundwater in the Whittier Narrows area. The project was designed to study the fate of significant mineral, organic, and biological constituents of renovated wastewater and the phenomena associated with their removal or transformation.

Mearns, A.J. and M. J. Sherwood.

Environmental Aspects of Fin Erosion and Tumors in Southern California Dover Sole.

Transactions of American Fisheries Society. 103(4):799-810. October 1974.

Key Words: chlorinated hydrocarbons, synthetic/organics, fish, surface water (marine).

Abstract:

Between 1969 and 1972, a number of Dover sole (*Microstomus pacificus* Lockington) with eroded fins and skin tumors were collected in a series of trawls off the coast of southern California. Field and laboratory observations suggest that the two diseases were distinct syndromes operating at different growth stages in the life cycle of the Dover sole.

Specimens with fin erosion were concentrated in the vicinity of the major municipal wastewater discharge site in the southern California area. Histological observations showed the disease to be external in nature: The distribution of the diseased fish and the patterns of erosion of the various fins suggest that the disease was brought on by contact with the sediments around the wastewater outfall.

Tumor-bearing specimens were more evenly distributed throughout the southern California coastal waters, and the presence of the anomaly appeared to be a function of fish size (usually occurring in specimens of less than 150 mm standard length). The spatial and temporal distributions of tumor-bearing Dover sole suggest that initiation of the disease was not related to wastewater discharges.

Mearns, A.J. and M.J. Sherwood.

Ocean Wastewater Discharge and Tumors in a Southern California Flatfish.

Presented at the Conference of the International Union Against Cancer, Cork, Ireland. October 15-17, 1974.

Key Words: copper, DDT, surface water (marine).

Abstract:

Based on the data collected, it is believed that the Dover sole skin tumor disease is not enhanced by the discharge of municipal waste in southern California and would not be reduced in overall incidence by projected improvements in waste treatment unless such changes affected the survival or recruitment of juvenile Dover sole. However, the disease may be associated with a very specific yet widely distributed agent that may or may not be related to wastes produced by industrial development. It is believed that changes in waste treatment will affect the distribution of Dover sole with fin erosion, and that this disease, on a local scale, may be a most important sign of environmental damage.

A comprehensive field program is an important part of any disease study, and sampling programs should be designed with the population characteristics of the affected species in mind: Sampling method, net mesh size, season, and depth range are important considerations in providing data for comparing different areas and for discovering correlations with potential causative agents.

Melnick, J.L., V. Rennick, B. Hampile, N.J. Schmidt, and H.H. Ho.

Lyophilized Combination Pools of Enterovirus Equine Antisera: Preparation and Test Procedures for the Identification of Field Strains of 42 Enteroviruses.

Bulletin of the World Health Organization. 48:263-268. 1973.

Key Word: epidemiology.

Abstract:

This paper describes the preparation of 8 dried pools (designated A to H) of sera. Each pool is composed of 10 or 11 of 42 individual enterovirus equine sera and contains 500 antibody units of each serum component per 0.1 ml. Procedures for using the anti-serum pools are given, and guidance is provided for interpreting the results of serum neutralization tests in identifying field isolates.

Mennell, M., D.T. Merrill, and R.M. Jorden.

Treatment of Primary Effluent by Lime Precipitation and Dissolved Air Flotation.

JWPCF. 46(11):2472-2485. November 1974.

Key Words: suspended solids, COD, phosphates, coliforms, chemical treatment, air flotation thickeners.

Abstract:

This continuous flow, bench-scale, pilot-plant investigation has shown the feasibility of treating primary wastewater effluent by lime precipitation and dissolved air flotation. Lime reaction, flocculation, and flotation operating parameters have been studied.

Mercado-Burgos, N., R.C. Hoehn, and R.B. Holliman.

Effect of Halogens and Ozone on Schistosoma Ova.

JWPCF. 47(10):2411-2419. October 1975.

Key Words: parasitic worms, ozonation.

Abstract:

The following conclusions were reached:

1. Chlorine is approximately 4 to 7 times more effective than bromine or iodine (on a concentration basis) against Schistosoma mansoni ova in wastewater. Average residuals of 1.35 mg/l after 30 min contact were 100 percent effective. For 5 and 15 min, effective average residuals were 3.29 and 1.78 mg/l.

2. While iodine is a less effective schistosome ovicide than bromine on a residual milligram per liter basis, it is more effective in terms of dose applied, probably because free bromine is lost easily from solution.

3. Chloramines are effective against schistosome ova in water at approximately the same concentrations observed to be lethal to ova in secondary treated wastewater effluents. Thus, chloramines, and not toxic organics, seem to be the lethal agents.

4. The ozone demand of wastewater makes disinfection of schistosome ova by ozone difficult. Dosages to 25 mg/l were ineffective. In one test at 40 mg/l, 100 percent kill was observed, but no replicates were conducted to verify this dosage. In no test in wastewater was there a residual 5 min after dosing; however, the physical aspects of the ozonation apparatus were partially responsible. Also, ozone does not form residual complexes with organics as the halogens do.

5. In dechlorinated tap water, ozone dosages of 15 mg/l were ineffective against schistosome ova in two tests in which the residual concentrations 5 min after dosing were 0.09 mg/l. In a third test at the same dosage, 100 percent kill was observed when the residual was 0.13 mg/l. More research is needed to determine whether the breakpoint for ozone toxicity is between 0.09 and 0.13 mg/l.

Mercer, B.W., L.L. Ames, C.J. Touhill, W.J. VanSlyke, and R.B. Dean.

Ammonia Removal from Secondary Effluents by Selective Ion Exchange.

JWPCF. 42(2):R95-R107. February 1970.

Key Words: ammonia, adsorption/ion exchange.

Abstract:

The removal of ammonia from secondary effluent was demonstrated successfully on a laboratory and pilot scale with a selective ion exchange process. The significant results of this program are:

1. Greater than 99-percent ammonia removal was demonstrated in the laboratory with 2 zeolite columns in series and clarified secondary effluent containing 10 to 19 mg/l ammonia nitrogen. From 200 to 300 column volumes of secondary effluent normally can be processed to full column loading.

2. Laboratory elution studies show that regeneration can be accomplished with about 20 column volumes of recycled regenerant containing lime applied at the rate of 10 column volumes per hour. More than 95 percent of the available ammonia capacity was restored with this treatment. The presence of sodium ion in the recycled regenerant minimizes the volume of regenerant required for elution of the ammonia.

3. No liquid regenerant waste is produced since the spent regenerant is air-stripped to remove ammonia and reused after the addition of more lime. The ammonia is exhausted harmlessly to the atmosphere from the air stripper.

4. Residual alkalinity in a freshly regenerated elinoptilolite bed causes some ammonia leakage during the initial part of the loading cycle. Backwashing with ammonia-free water, i.e., product water from the elinoptilote beds in service, is recommended for removing the residual alkalinity.

5. An average ammonia removal of 97 percent was attained for two 500-gal (1,893-1) elinoptilolite columns in the mobile demonstration plant with clarified secondary effluent containing 16 mg/l ammonia nitrogen. The flow rate was 6.0 gpm/sq ft (244.2 l/min/sq m) for a total of 70,000 gpd (265,000 l/day).

6. An average ammonia removal of 93 percent was attained for two 330-gal (1,250-1) elinoptilolite columns with

secondary effluent containing 15 mg/l ammonia nitrogen. Although the secondary effluent was simply filtered through a multimedia filter without chemical coagulation, no zeolite bed plugging problems were encountered with this feed. The flow rate was 8.4 gpm/sq ft (341.9 l/min/sq m) for a total of 100,000 gpd (379,000 l/day). Laboratory studies indicated fouling of the zeolite with unclarified secondary effluent.

7. Elution of ammonia from the mobile demonstration ion-exchange columns with recycled regenerant was quite effective; however, regeneration time was longer than anticipated because of low stripping efficiency. Optimum air-liquid contact apparently was not attained in the air-stripping tower.

Merrell, J.C. and A. Katko.

Reclaimed Wastewater for Santee Recreational Lakes.

JWPCF. 38(8):1310-1318. August 1966.

Key Words: chlorides, boron, phosphates, BOD, COD, fecal streptococci, coliforms, activated sludge, drinking and recreational water, effluent characteristics.

Abstract:

Treatment effectiveness of both the conventional treatment plant and the additional processes has been summarized. The treatment plant operates within the 80-90 percent range of efficiencies. The intermittent sand filtration process that was required for obtaining approval for recreation has proved to be the barrier that has effectively increased removals of organics and nutrients to the 98-99 percent range. This has made possible a lake environment suitable for multiple recreational uses. The 7 lb/day (3.2 kg/day) of nitrogen that has entered Lake 4 amounts to a concentration of from 2 to 3 mg/l. The lowest levels of all residual materials have been obtained for waters moving the greatest distance underground.

Merrell, J.C. and P.C. Ward.

Virus Control at the Santee, California Project.

JAWWA. 61(2):145-153. February 1968.

Key Words: viruses, drinking and recreational water, activated sludge, chlorination.

Abstract:

Removal of virus contamination in the reclaimed wastewater at Santee was accomplished because of a non-bypassable complete system of treatment. Evaluation of water safety required collection of numerous samples for virus identification and an exceptional degree of experience and training in virological laboratory procedures. It is likely that similar treatment effectiveness can be obtained elsewhere under the same high degree of treatment. Virus monitoring of this degree of effectiveness will never be routine and it does appear that viruses are neither a convenient nor a suitable indicator of sanitary quality. Although the cost of laboratory equipment is not excessive, the staff expertise and time-consuming work involved for proving a negative result or typing a positive isolation are prohibitive as routine practice. The total laboratory cost per sample at the Santee Project was in excess of $200. The science of virology is, however, a reliable tool, and it is suggested that the next step in the control of viruses in wastewater be quantitation and the development of relations between the identifiable viruses and their infectivity via the water route.

Merten, U. and D.T. Bray.

Reverse Osmosis for Water Reclamation.

Advances in Water Pollution Research. 1966(3):315-331.

Key Words: ammonia, total dissolved solids, chlorides, phosphates, COD, iron, reverse osmosis.

Abstract:

Experience to date indicates that the reverse osmosis approach to wastewater reclamation can yield reclaimed water of rather high quality and that highly selective membranes operating in a thoroughly treated secondary effluent have quite stable flow characteristics for periods of at least 1,500 hr. There is also some evidence that the problems of using less selective but more permeable membranes and of operating with less highly treated effluents, are solvable. Longer-term experiments in pilot-plant-scale equipment now are required to define the potentialities of the process.

Metcalf, R.L., K.A. Reinbold, J.R. Sanborn, W.F. Childers, and W.N. Bruce.

Comparative Biochemistry, Biodegradability and Toxicity of DDT and Carbofuran Analogues.

University of Illinois, Urbana, Water Resources Center, December 1974. 51p. (Available from National Technical Information Service (NTIS) as PB-239 252).

Key Words: DDT, surface water (fresh), livestock.

Abstract:

The aquatic persistence, toxicity, and biodegradability of DDT, methoxychlor, and 28 analogues were evaluated using the green sunfish Lepomis cyanellus. Study of DDT analogues with degradophores located in aryl or alkyl moieties of the DDT-type molecule showed that the toxicity to and persistence of these compounds in the green sunfish is correlated with the environmental temperature of exposure and ability of multi-function oxidase enzymes of the fish to attack specific chemical groupings on various parts of the molecule. The green sunfish can readily oxidize alkyl and methylthio groups of the aryl portion of the molecule to water partitioning moieties but alkoxy groups are not as readily attacked. Persistent and highly insecticidal DDT molecules can be developed which have greatly reduced toxicity to fish. The biochemical role of the multi-function oxidase enzymes in biodegradation of pesticides in the green sunfish was explored in detail.

Metcalf, R.L., G.M. Booth, C.K. Schuth, D.J. Hansen, and P. Lu.

Uptake and Fate of Di-2-ethylhexyl Phthalate in Aquatic Organisms and in a Model Ecosystem.

Environmental Health Perspectives. 1:27-33. June 1973.

Key Words: synthetic/organics, surface water (marine).

Abstract:

The experiments reported in this article demonstrate that DEHP is a microchemical environmental pollutant which is rapidly biomagnified by a variety of plants and animals in an aquatic system. DEHP is biodegraded very slowly in algae, daphnia mosquito larvae, snails, and clams and more rapidly in fish by hydrolysis at the ester bonds to form monoethylhexyl phthalate, phthalic acid, phthalic anhydride, and a variety of polar metabolites and conjugates. However, DEHP closely resembles DDT in rate of uptake and storage, and it obviously partitions strongly in the lipids of plants and animals and is concentrated through food chains. The biomagnification of DEHP together with its teratogenic properties and its enormous rate of production and ubiquitous use indicate the need for much further study of its environmental distribution and fate. Present data suggest the need for restrictions on the use and waste disposal of DEHP.

Metcalf, T.G.

Evaluation of Shellfish Sanitary Quality by Indicators of Sewage Pollution.

To be presented at International Symposium on Discharge of Sewage from Sea Outfalls, London, August 1974.

Key Words: coliforms, shellfish, salmonella, viruses.

Abstract:

Microbiological evaluation of shellfish sanitary quality has been regarded in some quarters as an imperfect art executed in an imperfect way. The use of a fecal coliform index for detection of fecal pollution is central to any discussion on microbiological aspects of shellfish sanitation. The studies described focused on extensive field examinations of the usefulness of fecal coliform indices as a measure of the presence of salmonellae and viruses in shellfish. The fecal coliform index was found to provide useful information when the fecal pollution measured was moderate to excessive. Correlation between coliform-indicated sanitary status and the actual status determined by direct examination was quite good. Inadequacies of the index were detected increasingly with declining levels of pollution. Correlation between indicated and actual microbiological quality became erratic in sea water at numbers less than 70 per 100 ml, or less than 230 per 100 g in shellfish. An acceptable coliform index of overlay water had little significance for the actual microbiologic quality of oysters. The most pronounced inadequacies occurred in the presence of enteric viruses.

Study results offered a possible explanation for inaccuracies of coliform indices at low incidences of fecal pollution, and suggested remedial measures. Continual monitoring of water showed significant fluctuations of coliform numbers to be possible at rapid intervals. The probable irregular periodicity of pollutant introduction into shellfish waters could only be detected by continuous monitoring. Initiation of a continuous monitoring policy would serve three important purposes. It would permit recognition of fluctuating coliform numbers, provide a truer picture of microbiologic quality, and might help to explain current inadequacies associated with sanitary interpretations drawn from coliform indices.

Metcalf, T.G. and W.C. Stiles.

Survival of Enteric Viruses in Estuary Waters and Shellfish.

In: Transmission of Viruses by the Water Route. G. Berg, ed.
Wiley, New York, 1965. pp. 439-447.

Key Words: coxsackie virus, polio virus, ECHO virus, surface water (marine), shellfish, surface water (fresh).

Abstract:

This study showed that survival of enteric viruses in estuary waters is dependent on temperature, pollution levels, and virus identity. The Coxsackie virus exhibited the greatest survival capacity, the poliovirus exhibited the least and the ECHO virus was intermediate. Comparisons of survival times with the results of others are not feasible because of differences in technical details.

Metcalf, T.G. and W.C. Stiles.

Viral Pollution of Shellfish in Estuary Waters.

Journal of the Sanitary Engineering Division, ASCE. 94(SA4): 595-609. August 1968.

Key Words: viruses, shellfish, surface water (marine).

Abstract:

Transmission of human enteroviruses via water to shellfish was studied in a sewage-polluted estuary.

Municipal waste treatment plants including those chlorinating wastewater, regularly contributed enterovirus to estuary waters. Data were obtained suggesting that chlorination effectively lowered virus incidence, provided enough chlorine was used or adequate retention time observed.

Widespread dissemination of enterovirus in estuary waters was followed by widespread appearance of the same virus types in shellfish. Examination of shellfish and overlaying water was necessary to obtain a complete picture of virus pollution. Enterovirus was removed from oysters by depuration in estuary waters. Virus retention was favored by high viral numbers and water temperatures below 10°C.

Enterovirus was isolated from seawater and oysters collected from seawater and meeting the recommended standard of not over 70 coliform median MPN per 100 ml. The finding of virus in seawater and shellfish, both meeting recommended sanitary standards, was considered evidence of the desirability of developing virologic standards for the sanitary examination of shellfish.

Metzler, D.F., R.L. Culp, H.A. Stoltenberg, R.L. Woodword, G. Walton, S.L. Chang, N.A. Clarke, C.M. Palmer, and F.M. Middleton.

Emergency Use of Reclaimed Water for Potable Supply at Chanute, Kansas.

JAWWA. 50(8):1021-1057. August 1958.

Key Words: BOD, COD, chlorides, ammonia, nitrates, nitrites, phosphates, iron, manganese, trickling filters, influent characteristics, effluent characteristics.

Abstract:

During the period of water reuse, the sewage treatment plant removed, on the average, 86 percent of the BOD and 76 percent of the chemical oxygen demand. It provided substantial reduction in both total and ammonia nitrogen concentrations. Sewage treatment also reduced alkyl benzene sulfonate (ABS) an average of 25 percent and complex phosphates by 67 percent.

The impounding reservoir served very effectively as a waste stabilization pond. It reduced the applied BOD and chemical oxygen demand loading by approximately 75 percent; the total and ammonia nitrogen concentrations by more than 55 percent; and the ABS by more than 50 percent.

Meyer, R.C., F.C. Hines, H.R. Isaacson, and T.D. Hinesly.

Porcine Enterovirus Survival and Anaerobic Sludge Digestion.

In: Livestock Waste Management and Abatement; Proceedings of the International Symposium on Livestock Wastes. American Society of Agricultural Engineers, St. Joseph, Michigan, 1971. pp. 183-184.

Key Words: viruses, anaerobic digestion.

Abstract:

This is a study of the fate of known enterovirus when exposed to anaerobic digestion.

Meyer, W.T.

Epidemic Giardiasis: A Continued Elusive Entity.

Rocky Mountain Medical Journal. 70:48-49. October 1973.

Key Word: epidemiology.

Abstract:

Giardiasis continues to be an elusive entity even in endemic situations. Both acute and chronic forms exist and controversy persists about the predilection for certain age groups.

The problems that confront an epidemiologist in evaluation of a possible giardiasis epidemic are multiple and include (a) Variable incubation period from 1 week to 4 weeks; (b) general lack of available valid endemic prevalence rates; and (c) possibility of various modes of transmission occurring simultaneously.

A common source, namely water, has generally been implied but has rarely been validated. In this respect, it seems reasonable to advocate routine monitoring of water facilities in high-risk or endemic areas. A method is advocated.

Compared to the vast amount of money expended on epidemic investigations which often turn out to be inconclusive, the additional expense of monitoring water facilities is justified.

Colorado is recognized as already taking steps towards proper surveillance of giardiasis and it is advised that especially those states in the Rocky Mountain regions of the United States take similar precautionary steps.

Meyers, J.D. and J.J. Witte.

Outbreaks of Waterborne Disease in the United States, 1971-1972.

Journal of Infectious Diseases. 129(5):614-616. May 1974.

Key Word: epidemiology.

Abstract:

This article includes average annual number of waterborne disease outbreaks in the U.S. for 1938-1972, waterborne outbreaks by disease and type of water system in the U.S. from 1971-1972, and waterborne outbreaks by type of water system and cause in U.S. from 1971-1972.

Meynell, G.G.

The Effect of Sudden Chilling on Escherichia coli.

Journal of General Microbiology. 19:380-389. 1958.

Key Words: Escherichia coli, air.

Abstract:

As found by earlier workers, Escherichia coli, growing in broth at 37° was rendered incapable of gross multiplication either on nutrient agar or in nutrient broth by sudden cooling in many diluents at 4°. Killing is due to the joint action of a suitable diluent and of sudden chilling, since survival was complete either after sudden chilling in 0-8M-sucrose or after gradual cooling in a potentially lethal diluent, such as Ringer's solution. Organisms in the stationary phase of growth were completely resistant. The susceptibility of growing organisms in sudden chilling changed rapidly during the exponential phase. Comparison with the survival after exposure to streptomycin, another bactericidal agent which has no effect on stationary phase cultures, showed that survival after chilling was not due to a fraction of the population being in the stationary phase.

Sudden cooling of Escherichia coli, strain B, infected with phage T2, had the same effect as ultrasonic disruption; namely, destruction of infective centres in the first half of the latent period followed, in the second half, by release of intracellular mature phage.

Michelsen, D.L.

The Removal of Soluble Mercury from Waste Water by Complexing Techniques.

Virginia Polytechnic Institute and State University, Blacksburg, 1973. 90p. (Available from National Technical Information Service (NTIS) as PB-232 256).

Key Words: mercury, adsorption/ion exchange.

Abstract:

Milk proteins, xanthates, modified rubber products, and keratin in various forms can be used for the removal of ionic mercury from water systems. In particular anionic and cationic ion exchange products made from ground tire cord rubber compete very favorably with classical ion exchange resins with regard to capacity, and rate of pick-up. Cow and pig hair selectively remove ionic mercury and the performance with tannery hair based on equilibrium capacity, rate of removal and pressure drop was good. Regenerative studies of ionic mercury from tannery hair with HCl and NaCl were successful, and a number of scale-up studies including economics were completed to illustrate how tannery hair might be used for the treatment of waste streams containing ionic mercury.

Microbiological Considerations in the Use of Sewage Sludge for Agricultural Purposes.

East Bay Municipal Utility District Soil Enrichment Study, Oakland, Calif., 1974. 68p.

Key Words: salmonella, shigella, protozoa, viruses, bacteria, coliforms, mycobacterium, parasitic worms, *Escherichia coli*, fecal streptococci, surface water (marine), crops, livestock, agriculture.

Abstract:

This article gives a complete review of pathogenic organisms associated with the use of wastewater and sludge on agricultural crops, their numbers after certain treatments, and pathways to man.

Miller, G.T.

Living in the Environment, Concepts, Problems, and Alternatives.

Wadsworth Publishing Company, Belmont, Ca. 1975. 578p.

Key Word: epidemiology.

Abstract:

This is a textbook with contents including man and nature, concepts of ecology, population, resources and population, and environment and society.

Miller, R.H.

Microbiology of Sewage Sludge Disposal in Soil.

Ohio Agricultural Research and Development Center, Wooster, November 1974. 132p. (Available from National Technical Information Service (NTIS) as PB-237 817).

Key Words: coliforms, fecal streptococci, nitrates, viruses, land reclamation.

Abstract:

Laboratory studies were conducted to evaluate some of the factors which influence the microbial degradation of anaerobically digested sewage sludge in soils and the population of microorganisms involved in these processes. Anaerobically digested sewage sludge was rather resistant to decomposition with a maximum of about 20% of the sludge carbon evolved as CO_2 in six months. The rate of decomposition at the high loading rates of 90 and 224 metric tons/ha of dry solids was found to be independent of differences in soil chemical properties. Differences in soil texture influenced sludge decomposition indirectly by influencing soil aeration under saturated moisture conditions. A relationship was shown between the percent sludge carbon evolved as CO_2 and monthly degree days which will provide a method for predicting the amount of sludge decomposition in a given climatic area based on available temperature data. Accumulation of soluble soil nitrogen and soluble salts in sludge amended soils could limit the rate of application sewage sludge to soils.

Miller, R.H.

The Soil as a Biological Filter.

In: Conference on Recycling Treated Municipal Wastewater through Forest and Cropland. E. Sopper and L. Kardos, eds. EPA-660/2-74-003. Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp. 73-94. (Available from National Technical Information Service (NTIS) as PB-236 313).

Key Words: BOD, copper, zinc, synthetic/organics, DDT, aldrin, dieldrin, herbicides, salmonella, shigella, mycobacterium, Vibrio cholerae, hepatitis virus, Adeno virus, coliforms, nitrates, phosphates, iron, manganese, ponding/land application, groundwater.

Abstract:

This paper reviews the various microbial reactions which influence the success of soil as a filter for renovating municipal wastewater and sludge. The majority of these activities are beneficial, actually essential, for maintaining the integrity and effectiveness of the soil filter. Only one reaction, nitrification, can be considered detrimental to the success of the soil filter when the disposal method maintains adequate soil aeration.

Prolonged periods of anaerobiosis must be avoided for the proper functioning of the microbial component of the soil filter. Proper management of land disposal systems for liquid waste regardless of the mode of application must provide for periods of adequate aeration. Failure to do so will result in reduced decomposition of organic wastes, odors, reduction and mobilization of Fe and Mn, changes in the solubility of other inorganic ions, and inundation of vegetative cover. In addition, anaerobic conditions in the soil surface with microbial cells, polysaccharides, and ferrous and manganous sulfides which reduces water infiltration.

Miller, R.H.

Soil Microbiological Aspects of Recycling Sewage Sludges and Waste Effluents on Land.

In: Recycling Municipal Sludges and Effluents on Land; Proceedings of the Joint Conference, July 9-13, 1973. pp. 79-90.

Abstract:

The biological component of soil which includes bacteria, actinomycetes, fungi, algae and soil micro- and macro-animals makes significant contributions to waste recycling by decomposing waste organic compounds; eliminating some environmental toxins; eliminating pathogenic microorganisms; involvement in the nitrogen, phosphorus and sulfur cycles; and by influencing the solubility and mobility of inorganic ions in soil. Our present knowledge of these microbial reactions is reviewed and used to emphasize significant areas of needed research.

Miller, T.A. and S.A. Schaub.

Health Effects of Feeding Domestic Animals on Crops Harvested from Land Wastewater Disposal Sites.

U.S. Army Medical Bioengineering Research and Development Laboratory, Ft. Detrick, Md., 1975.

Key Words: salmonella, parasitic worms, viruses, bacteria, hepatitis virus, chlorinated hydrocarbons, crops, livestock, agriculture.

Abstract:

There are a significant number of Environmental Protection Agency, Department of Agriculture, and Food and Drug Administration supported projects underway, or about to be initiated, concerning health implications of chemical and biological constituents in sludge/wastewater applied to the land. Most of the current or planned studies involve investigations of raw or digested sludge at sites where the sludge has been applied for some time. Several studies involve feeding sludge directly to animals, since foraging livestock, especially cattle, may ingest considerable amounts of sludge and soil along with the crops. Unfortunately, results and conclusions from studies of sludges are not directly comparable to results which might be obtained in studies involving the use of wastewater.

The chemical constituents in digested sludges thought to have the most impact upon animal and human health are heavy metals (especially cadmium and lead) and possibly pesticides, polychlorinated biphenyls and other refractory organics. Digested sludge would have considerably fewer pathogens/parasites than raw sludge, but in both cases parasite eggs and cysts, and certain resistant bacteria, such as mycobacterium or Bacillus sp/Clostridium sp, could be a problem.

Millette, E. D.

Adsorption of Phosphorus by Unsaturated Synthetic Soil.

Purdue University, Lafayette, Indiana, Water Resources Research Center, May 1974. 205p. (Available from National Technical Information Service (NTIS) as PB-240 116).

Key Words: phosphates, effluent characteristics.

Abstract:

Various concentrations of potassium phosphate solution were admitted to short soil columns in a reaction chamber. The phosphate solution contained a tracer which was chemically the same as the main solute. After reaction, the effluent was collected and the amounts of phosphate removed determined. The removal was a function of the soil water tension as well as the inlet concentration of phosphorus and the relative presence of clay in the soil. The higher the soil water tension, the higher the inlet concentration and the greater the clay fraction, the greater were the amounts of phosphate adsorbed by the soil. Of the four adsorption equations examined, the Langmuir and the Freundlich equilibrium adsorption isotherms gave the best prediction of uptake. Portions of the document are not fully legible.

Miner, J.R., R.I. Lipper, L.R. Fina, and J.W. Funk.

Cattle Feedlot Runoff - Its Nature and Variation.

JWPCF. 38(10):1582-1591. October 1966.

Key Words: COD, ammonia, nitrites, suspended solids,
surface water (fresh).

Abstract:

Runoff from cattle feedlots is a high-strength organic waste produced during and immediately after rainfall. These studies indicated that greatest pollutant concentrations are obtained during warm weather, during periods of low rainfall intensity, and when the manure has been made soluble by soaking with water. Correlations were developed to predict runoff oxygen demand and nitrogen content based on these factors.

In addition, the following points were demonstrated: (a) Feedlot runoff is a source of high concentrations of bacteria normally considered as indices of sanitary quality, and (b) runoff from a concrete-surfaced lot was more heavily polluted than that from a nonsurfaced lot under similar conditions.

Miner, J.R., L.R. Fina, and C. Piatt.

Salmonella infantis in Cattle Feedlot Runoff.

Applied Microbiology, 15(3):627-628. May 1967.

Key Words: salmonella, drinking and recreational water.

Abstract:

Ten isolates of *Salmonella infantis* (serologically typed) were found in litter and runoff collected from two experimental feedlots near the Kansas State University campus. Pathogenic implications are discussed relative to recreation water sites. Agricultural runoff may be a source of viable salmonellae.

Mitchell, F.K.

Comparison of Primary and Secondary Treatment.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1974. pp. 163-165.

Key Words: arsenic, cadmium, copper, lead, mercury, nickel, zinc, cyanides, chemical treatment.

Abstract:

This article gives good general data for comparison of effluents from various municipal wastewater treatment processes.

Mitchell, F.K.

Properties of Ocean Sludge.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1974. pp. 159-162.

Key Words: cadmium, lead, surface water (marine).

Abstract:

Dilution is an important factor in determining settling velocity distributions in the ocean from an outfall. Increased dilution results in suspensions with lower mean settling velocities. Data shows a highly correlated relationship between heavy metal concentrations and organic carbon concentrations.

Mitchell, F.K. and D.J. McDermott.

Characteristics of Municipal Wastewater Discharges, 1974.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 1975. pp. 163-165.

Key Words: suspended solids, BOD, COD, oil and grease, nitrates, ammonia, phosphates, cyanide, synthetic/organics, arsenic, cadmium, chromium, copper, iron, mercury, manganese, nickel, lead, selenium, zinc, DDT, dieldrin, chlorinated hydrocarbons, effluent characteristics.

Abstract:

This paper presents data from municipal wastewater dischargers.

Mitchell, F.K. and H.A. Schaffer.

Effects of Ocean Sludge Disposal.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 1975. pp. 153-162.

Key Words: suspended solids, COD, BOD, oil and grease, ammonia, phosphates, cadmium, chromium, copper, lead, nickel, zinc, mercury, chlorinated hydrocarbons, DDT, surface water (marine).

Abstract:

More than 90 percent of the possible pollutants discharged through the Hyperion 7-mile pipeline are associated with particulate matter, and the association of these pollutants with the particulates is essentially unchanged by mixing with seawater.

The transport of the discharged particulate matter is predominantly downcanyon.

The current rate of discharge of particulate matter represents 20 percent of the total (effluent plus natural) particulate matter settling to the bottom in the Santa Monica Submarine Canyon study area (69 sq km); the effluent contribution of organic matter to the bottom is twice the noneffluent organic input. Major sediment quality alterations resulting from 15 years of treatment plant sludge discharge are confined within the canyon, are greatest nearest the discharge point, and decrease very rapidly with distance.

The rate of decomposition of organic matter in the sediments is substantially greater than the rate of trace metals mobilization.

A layer of (primarily) sludge particulates exists on the canyon floor in the immediate vicinity of the outfall. This layer is approximately 25 cm deep and covers an area of about 2 sq km. Comparison with 1971 data indicates that this layer of sludge is not moving and that surface sediment quality has not changed noticeably between 1971 and 1974.

Mitchell, R.

The Fate of Viruses in Relation to Deep Current Assimilation of Sewage.

Report to the City of Miami Beach, Florida. 1975. 5p.

Key Words: viruses, surface water (marine).

Abstract:

The City of Miami Beach is requesting permission from EPA to inject its sewage into the Gulf Stream for deep current assimilation. The author, an expert in the area of virus inactivation in seawater, argues that this is unlikely to present a health hazard.

Mitchell, R. and C. Chamberlin.

Factors Influencing the Survival of Enteric Microorganisms in the Sea: an Overview.

To be presented at International Symposium on Discharge of Sewage from Sea Outfalls, London, August 30, 1974.

Key Words: bacteria, surface water (marine).

Abstract:

Based on the extensive laboratory and field studies that have been carried out over the past several decades, it has been possible to develop a mathematical and conceptual framework for interpreting and comparing experimental results on the die-off of bacteria in the sea. The work presented in this Symposium and elsewhere attests both to the scope and to the detail of the multi-disciplinary effort in this field that ranges from concern with viral inactivation to hydrodynamic modelling. Drawing upon these diverse areas, it has seemed possible to deduce the potential significance of various factors that have been investigated. It is proposed that solar radiation, sedimentation, and nutrient-related effects account for the bulk of the observed die-off. It is further proposed that this or similar models might prove useful in outfall site evaluation and more refined consideration of enteric pathogen die-off in the sea.

Mitchell, R. and J.C. Morris.

The Fate of Intestinal Bacteria in the Sea.

Advances in Water Pollution Research. 1969. 811-817.

Key Words: bacteria, Escherichia coli, coliforms, surface water (marine).

Abstract:

It is clear from these studies that the native marine microflora is intimately involved in the death of intestinal bacteria in the sea and that the rate of kill increases with increase of the marine microbial population.

At least two groups of bacteria have been found to be associated with the death of E. coli in sea water. One group, pseudomonas, causes death by enzymatically lysing the cell walls of the intestinal bacteria. A second group, bellovibrio is parasitic and acts by actively parasitizing the coliforms and using the whole cell as a carbon source. Nematodes also prey on intestinal bacteria. The effect of algae and protozoa has yet to be investigated. The relative importance of each of these groups of organisms in particular situations or under typical conditions has yet to be determined. It appears likely that the absolute and relative significance of each group will vary temporally and geographically, depending on the particular ecological situation. The lethal effects of marine environments on intermixed sewage bacteria must then be studied in terms of prevalent local conditions rather than as a universally uniform phenomenon.

The application of these biological parameters to the death of intestinal microorganisms in non-marine aquatic systems and in sewage treatment remains to be determined. However, there is reason to believe that the ecological principles which apply in the sea, equally apply in other environments.

Mitchell, R. and S. Yankofsky.

Implication of a Marine Ameba in the Decline of *Escherichia coli* in Seawater.

Environmental Science and Technology. *3*:574-576. June 1969.

Key Words: *Escherichia coli*, surface water (marine).

Abstract:

The decline of *Escherichia coli* in seawater paralleled an increase in a specific microbial population capable of causing lysis of the intestinal bacteria. This population included a large number of marine amebae which were incapable of growing on artificial media. Pure cultures of the ameba were obtained and the organism was identified as *Vexillifera telmathalassa*. Addition of the ameba to sterile natural sea water together with *E. coli* resulted in a rapid kill of the intestinal bacterium. The importance of the marine microflora in the decline of intestinal bacteria in the sea is discussed.

A previous study has shown that the fate of *Escherichia coli* in sea water is linked to the activities of the marine microflora. That study showed that marine bacteria capable of lysing *E. coli* cell walls and other lytic microorganisms were involved in the decline of intestinal bacteria in sea water.

In the current study, marine amebae are also shown to be involved in the decline of this intestinal bacterium in natural sea water. The ameba vexillifera apparently is indigenous to the sea and is rapidly enriched in the presence of high concentrations of *E. coli*. The fact that this organism seems to feed exclusively on living bacteria, and the small size of the native marine microbial population, would explain the rapid response of the ameba population to inoculation of *E. coli*.

Mitchell, R., S. Yankofsky, and H.W. Jannasch.

Lysis of Escherichia coli by Marine Microorganisms.

Nature. 215(5103):891-893. August 19, 1967.

Key Words: Escherichia coli, surface water (marine).

Abstract:

The fact that the lethal effect of seawater on E. coli increases (a) with increasing population size, as determined on a peptone-yeast extract agar, and (b) with an increasing number of lytic bacteria on inoculation with E. coli supports the assumption that the indigenous microflora contributes significantly to this effect. A more complex effect is suggested by the results of studies on other qualities of seawater, especially heavy concentration of metal and the presence of algal toxins. It seems reasonable to assume that the nature of the lethal effect of seawater on E. coli will vary with seasonal and local changes of the environmental conditions.

Miyazaki, S. and A.J. Thorsteinson.

Metabolism of DDT by Fresh Water Diatoms.

Bulletin of Environmental Contamination and Toxicology.
8(2):81-83. August 1972.

Key Words: DDT, DDD, surface water (fresh).

Abstract:

Results of this article suggest that some species of fresh water diatoms may be significant in the degradation of DDT to DDE.

Mogilner, B.M., J.S. Freeman, Y. Blashar, and F.E. Pincus.

Reye's Syndrome in Three Israeli Children: Possible Relationship to Warfarin Toxicity.

Israeli Journal of Medical Science. 10(9):1117-1125. 1974.

Key Word: epidemiology.

Abstract:

Three cases of Reye's syndrome are reported in two of which warfarin was considered to be of etiological importance. The clinical and pathological features of the syndrome are reviewed, and the etiology and pathogenesis discussed. An extreme acute stress response, causing toxic levels of fatty acids, is the most plausible common denominator of the multiple factors previously implicated in the etiology of Reye's syndrome. Warfarin is added to the list of factors predisposing to or causing the extreme acute stress.

Mohanrao, G.J., P.V.R. Subrahmanyam, S.B. Deshmukh, and S. Saroja.

Waste Treatment at a Synthetic Drug Factory in India.

JWPCF. 42(8):1530-1543. August 1970.

Key Words: synthetic/organics, combined municipal/industrial systems.

Abstract:

1. Before the factory was put into operation, the work on the treatment was started on simulated mixtures of wastes prepared according to the composition given by the factory authorities. Wastes from different blocks were characterized from the sanitary engineering point of view.

2. Block 8, producing intermediates and discharging 307 cu m/day of waste, contributed about 50 percent of the total waste. It contained appreciable quantities of inorganic acids such as hydrochloric and sulfuric, as well as sulfanilic acid (the only organic constituent). In view of the scope for recovering acids from Block 8 at a future date, wastes from this block were segregated and treated separately.

3. Wastes from Rest of Blocks (about 264 cu m/day) were alkaline (pH = 9.3), exerted high BOD (15,250 mg/l) and high COD (28,540 mg/l), and contained a large amount of nitrogen (5,200 mg/l) but no phosphorus. Wastes from All Blocks were very similar to that of Rest of Blocks except for very low pH (9.8).

4. Treatment of Block 8 wastes consisted of neutralization to pH 7.0 with 10 percent lime. As a result of this treatment, 34 percent reduction in sulfanilic acid was achieved. The filtration after lime neutralization is to be discharged into sewers. Since sulfanilic acid is readily biodegradable, the left-over sulfanilic acid will not have an adverse effect on wastewater treatment when it is discharged into sewers.

5. Chemical treatment for Rest of Blocks with coagulants like alum, ferrous sulfate, and ferric chloride did not show any material precipitation or clarification.

6. Biological treatment for Rest of Blocks was found to be effective. Acclimatization studies carried out have shown that the activated sludge process can efficiently treat 5 and 7 percent concentrations of the wastes from Rest of Blocks on batch- and continuous-feeding bases, respectively.

7. The amount of nitrogen in Rest of Blocks wastes was more than that required for efficient aerobic biological stabilization. On the other hand, phosphorus in any form was absent. Phosphorus in the form of dipotassium hydrogen phosphate was supplemented to give BOD:P of 100:1. The optimum phosphorus was calculated to be 0.84 kg P/100 kg BOD removed.

8. Studies on activated sludge acclimatized to waste from Rest of Blocks were carried out.

a. BOD to MLVSS (F/M) ratio of 0.29 was found to be optimum and gave 90 percent BOD removal with an aeration period of 8 hr.

b. Sludge-growth studies showed that, on the average, 0.56 kg of volatile solids was produced per kg of BOD removed.

c. The average sludge volume index and sludge density index were found to be 42 and 2.37, respectively. These values are considered to be very good for activated sludge.

Moje, W.

Organic Soil Toxins.

In: Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 533-569.

Key Words: synthetic/organics, ponding/land application, land reclamation, groundwater, crops.

Abstract:

It is now fairly well accepted that there are certain substances in soils which, under certain conditions, can be adverse to plant growth. The author discusses organic compounds actually isolated and identified in soils, root excretions, and crop residues which have been shown to be toxic to plant growth, or which have been suggested as causes of soil sickness or replant problems. These compounds include acids, aldehydes, amino acids, coumarins, and flucosides. The isolation and identification of organic soil toxins is considered and the author concludes that with the new techniques now available for identifying trace amounts of organic substances in soils, it should become increasingly feasible to assays soils with respect to the presence or absence of detrimental (or beneficial) organic components and to institute corrective measures.

Molina, J.E., O.C. Braids, and T.D. Hinesly.

Observations on Bactericidal Properties of Digested Sewage Sludge.

Environmental Science and Technology. 6(5):448-450. May 1972.

Key Words: bacteria, anaerobic digestion.

Abstract:

Liquid digested sewage sludge sampled directly from the digester exhibited a thermostable bacteriotoxin. The liquid phase of digested sludge rather than the solid phase contained the toxic agent. Of a variety of possible sources of toxicity, proteins, parasitic relationships, competition for nutrition, and antibiotics, were ruled out. Escherichia coli from stock culture had a higher mortality rate after addition to sludge than E. coli isolated from sludge. Sludge-isolated E. coli lost their tolerance after several transfers in lactose broth.

Monk, G.W., P.A. McCaffrey, and M.S. Davis.

Studies on the Mechanism of Sorbed Water Killing of Bacteria.

Journal of Bacteriology. 73:661-665. 1957.

Key Words: bacteria, groundwater.

Abstract:

The energy and entropy of activation for the killing of Serratia marcescens by sorbed water compares more closely to the values for endogenous respiration and growth than to those for thermal killing. At the most lethal water content of about 33 percent, the existence of measurable endogenous respiration indicates that at least part of the metabolic system is operative in the absence of only small amounts of water. A simple explanation is offered which assumes that a hygroscopic substance which is toxic under these conditions is all in solution at 33 percent water. In dryer cells less of this substance is in solution, and in wetter cells it is diluted and the cells can resume a more normal metabolic balance.

Monroe, D.W. and D.C. Phillips.

Chlorine Disinfection in Final Settling Basins.

Journal of the Sanitary Engineering Division, ASCE.
98(SA2):287-297. April 1972.

Key Words: coliforms, chlorination.

Abstract:

The findings of this study can be summarized as follows:

1. In general, the colicidal efficiency and residual chlorine decreased as the suspended solids concentrations of the samples increased.

2. The orthotolidine method for determining chlorine residual was found to be an unreliable indicator when used on trickling filter effluent, with chlorine residuals of 5.0 mg/l or less.

3. Chlorination of the settled filter effluent showed better coliform disinfection than did chlorination of the unsettled effluent. At a chlorine dosage of 1 mg/l, coliform regrowth occurred in both the settled and the unsettled samples after 2 hr of contact. The dosages of 2, 4, 5, and 8 mg/l all gave complete disinfection (less than 0.001% coliforms remaining) in less than 3 hr contact. The difference in the coliform disinfection rates of the settled and the unsettled samples decreased as the chlorine dosage was increased. At dosages of 4 mg/l and higher the difference in disinfection rates became insignificant.

4. The colicidal efficiency obtained by chlorinating settled effluent in a contact chamber was found to be consistently higher than that obtained by chlorinating unsettled effluent in a final settling tank. The difference was found to be small and insignificant at chlorine dosages greater than 2 mg/l. At dosages of 2 mg/l and lower, the concentration of coliforms in the settling tank effluent was as much as 10 times higher than the average concentration of coliforms in the contact chamber effluent.

Mood, E.W. and B. Moore.

Health Criteria for the Quality of Coastal Bathing Waters.

World Health Organization, Geneva, Switzerland, 1976. 39p.

Key Words: viruses, coliforms, bacteria, surface water (fresh). surface water (marine).

Abstract:

This article discusses health aspects of recreational bathing and swimming and recommended guidelines for quality of bathing waters.

Moore, D.P.

Mechanisms of Micronutrient Uptake by Plants.

In: Micronutrients in Agriculture. R.C. Dinauer, ed.
Soil Science Society of America, Madison, Wisconsin, 1972.
pp. 171-198.

Key Words: iron, manganese, zinc, copper, boron, ponding/land application, land reclamation, groundwater, crops.

Abstract:

Considerable controversy exists concerning the proposed mechanisms of iron uptake by plants, and there is voluminous literature supporting the various hypotheses. The bulk of the data, however, support the idea that ion transport in plants is an active metabolic process that is highly selective. Recent evidence would seem to favor the carrier theory of absorption over the Donnan system or the electropotential gradient hypothesis, but these three hypotheses are by no means mutually exclusive. Various aspects of these hypotheses are experimentally valid and any proposed mechanism of ion transport must recognize these aspects.

The rather limited data available on micronutrient absorption suggest that the mechanism of their uptake is similar to that for the macronutrients. There are important differences related to the quantity of the micronutrients required by plants, but the relationship to metabolism and the effect of concentration, pH, competing ions, and inhibitors are basically similar. Although the root is normally considered to be the absorbing organ, absorption characteristics of other plant tissues, including leaf tissue, suggest a common mechanism for all cells.

Moore, W.A., G.N. McDermott, M.A. Post, J.W. Mandia, and M.B. Ettinger.

Effects of Chromium on the Activated Sludge Process.

JWPCF. 33(1):54-72. January 1961.

Key Words: chromium, activated sludge.

Abstract:

During the period when the biological chromate reduction and removal system was operated the activated sludge contained up to 18.4 percent chromium on a dry solids basis. It is obvious that reduced chromium has little or no toxicity to activated sludge. The digester operated well with as much as 3.5 percent chromium in the solids. Clearly, the total treatment system studied was resistant to and tolerant of all but the most drastic stresses by chromate.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 23(34). August 24, 1974.

Key Word: epidemiology.

Abstract:

St. Louis Encephalitis in Tennessee and illness associated with TCDD-contaminated soil in Missouri are discussed.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 23(35). August 31, 1974.

Key Word: epidemiology.

Abstract:
A follow-up discussion on cholera in Guam is presented.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 23(36). September 7, 1974.

Key Word: epidemiology.

Abstract:
Cholera in Portugal and Spain, and surveillance of childhood lead poisoning are discussed.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 24(12). March 22, 1975.

Key Word: epidemiology.

Abstract:

This weekly report summarizes information received on vinyl chloride and congenital malformations, an outbreak of gastrointestinal illness at Crater Lake National Park, a trichinosis outbreak in Illinois, and current trends in primary and secondary syphilis.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 24(29). July 19, 1915.

Key Word: epidemiology.

Abstract:
This weekly report discusses gastroenteritis on cruise ships, nonhuman primate associated hepatitis in Pennsylvania and quarantine measures.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 24(46). November 15, 1975.

Key Word: epidemiology.

Abstract:

This issue discusses shigellosis in a church camp in Montana.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 24(51). December 20, 1975.

Key Word: epidemiology.

Abstract:

Deaths due to asphyxiation at an animal waste products rendering plant in Franklin County, Ohio, are discussed. The drain pipe was clogged for 2-7 days. The deaths were due to H_2S, CH_4, and CO.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 24(53). January 3, 1976.

Key Word: epidemiology.

Abstract:
This issue is an index of Volume 24, 1975.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(8). February 28, 1976.

Key Word: epidemiology.

Abstract:

Salmonella typhimuriam in the Canary Islands, Finland, and Germany, and ASL (Angiosorcoma of the Liver) in Wisconsin due probably to occupational exposure are discussed. (ASL is caused by the vinyl chloride monomer, thorium dioxide, and arsenic).

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(9). March 6, 1976.

Key Word: epidemiology.

Abstract:

Surveillance of childhood lead poisoning and botulism in the U.S. in 1975 are discussed.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(10). March 19, 1976.

Key Word: epidemiology.

Abstract:

This issue presents a discussion of Leptospirosis in Tennessee. Seven children swam in a local creek in the month preceding the illness.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(11). March 26, 1976.

Key Word: epidemiology.

Abstract:
Lead poisoning in Tennessee is discussed.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(15). April 23, 1976.

Key Word: epidemiology.

Abstract:

Chlordane contamination of a municipal water system in Tennessee is described.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(17). May 7, 1976.

Key Word: epidemiology.

Abstract:

Organic mercury exposure in Washington is discussed along with cholera-like illness associated with an enterotoxigenic strain of E. coli in Georgia.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(18). May 14, 1976.

Key Word: epidemiology.

Abstract:

Surveillance of childhood lead poisoning in the U.S. and recommendations for travelers to earthquake affected areas in Italy are presented.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(23). June 18, 1976.

Key Word: epidemiology.

Abstract:

A report on an occupational lead poisoning at a Salt Lake City (Utah) secondary lead smelter is presented, and salmonella infections of United Kingdom in 1975 are discussed.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(24). June 25, 1976.

Key Word: epidemiology.

Abstract:

This issue deals with the surveillance of childhood lead poisoning.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, NEW. 25(25). July 2, 1976.

Key Word: epidemiology.

Abstract:
Clostridium perfringens in Wisconsin were isolated from gravy which made a family of six ill.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(27). July 16, 1976.

Key Word: epidemiology.

Abstract:
Cholera worldwide in 1975 is discussed.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(29). July 30, 1976.

Key Word: epidemiology.

Abstract:

A discussion of diarrheal illness on a cruise ship caused by exterotoxigenic *E. coli* is presented.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(30). August 6, 1976.

Key Word: epidemiology.

Abstract:

Cigarette smoking in the U.S. in 1975 and St. Louis Encephalitis are discussed.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(31). August 13, 1976.

Key Word: epidemiology.

Abstract:

Diarrhea in bicyclers in Idaho and Montana was shown to be due to fecal contaminated wells.

In 1974, 8 of 28 waterborne outbreaks occurred among visitors to recreational areas.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(32). August 20, 1976.

Key Word: epidemiology.

Abstract:
Follow-up on the American Legionaire disease is presented, and salmonellosis caused by cheddar cheese in Colorado id discussed.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(33). August 27, 1976.

Key Word: epidemiology.

Abstract:

Follow-up on the Legionaire disease is presented and hazards of explosive azide are discussed.

Azide is used in automatic blood cell counters. After the blood count procedure is completed, the waste (containing azide) is commonly discharged into a drain, thus bathing the drain pipeline with solutions of sodium azide which eventually form copper, lead, or brass azides. Lead azide is more explosive than nitroglycerine.

Morbidity and Mortality Weekly Report.

U.S. Center for Disease Control, HEW. 25(34). September 3, 1976.

Key Word: epidemiology.

Abstract:

Legionaire disease is followed up, and botulism in infants is discussed.

Morel, F.M.M., J.C. Westall, C.R. O'Mella, and J.J. Morgan.

Fate of Trace Metals in Los Angeles County Wastewater Discharge.

Environmental Science and Technology. 9(8):756-761. August 1975.

Key Words: zinc, mercury, copper, cadmium, lead, chromium, nickel, cobalt, manganese, surface water (marine).

Abstract:

A chemical equilibrium model of the Los Angeles County sewage is presented which accounts for the chemical speciation of trace metals. Many metals are found in very insoluble sulfide (Zn, Hg, Ag, Cu, Cd, Pb) or oxide (Cr, Fe) forms, while some (Ni, Co, Mn) are relatively soluble. A study of the oxidation and dilution of the sewage by seawater demonstrates that most metals tend to be solubilized upon disposal in the ocean and that unmeasurable increments in the natural metal concentrations should result in the farfield. It is argued that the sewage particulate is not mobilized in the vicinity of the outfall and that the nearby sediments are a mixture of naturally occurring sediments and sewage particulate. About 0.5% of the sewage particulate - and its metal content - can be accounted for in the reduced area.

Morel, F., R.E. McDuff, and J.J. Morgan.

Interactions and Chemostasis in Aquatic Chemical Systems: Role of pH, pE, Solubility, and Complexation.

In: Trace Metals and Metal-Organic Interactions in Natural Waters. P.C. Singer, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1974. pp. 157-200.

Key Words: lead, copper, barium, cadmium, zinc, nickel, mercury, lead, cobalt, aluminum, surface water (fresh), surface water (marine).

Abstract:

By systematic studies of chemical equilibrium models for natural aqueous systems, we have found that the speciation of the trace metal ions is usually simple: free ions, solid carbonates, sulfides or hydroxides, chloride or sulfate complexes, etc. Because the complexing or precipitating ligands are usually in large excess of the metals, they mediate few important interactions (competition) among those metals. A most notable exception to this rule is observed under reducing conditions when a sufficiently large iron concentration precipitates most of the sulfide and keeps other trace metal ions from precipitating.

In ecological studies, general statements are often made upon the relations between complexity and stability, diversity and homeostasis, etc. In the far simpler chemical equilibrium systems we have dealt with, it is clear that no such general statement can be made. To be meaningful, the quantification of the concept of chemostasis, for a given chemical system, has to be the complete matrix of interaction intensities or equivalent quantities. To say that a system is more or less chemostable than another system is, thus, somewhat abusive. It is only in the case where we are interested in the effect of a given change on a given variable that the stability of two systems can be simply compared.

Morgan, J.J.

Physical-Chemical Forms of Chromium in Sewers, Treatment Works, and Coastal Water Environments.

Personal Communication.

Key Words: chromium, influent characteristics, activated sludge, surface water (marine).

Abstract:

Discharge of sewage effluent into the coastal marine environment, in addition to dilution, tends to: 1) solubilize $Cr(OH)_3(s)$; 2) desorb adsorbed Cr(III) forms, and; 3) leave Cr(VI) largely unaffected.

Morris, J.C.

Chlorination and Disinfection - State-of-the-Art.

JAWWA. 63(12):769-774. December 1971.

Key Words: viruses, ammonia, chlorination, disinfection.

Abstract:

Any body of water regularly receiving input of municipal or other human-waste waters should be regarded as significantly contaminated with virus until it has had at least 30 days of protected storage. The disinfecting treatment for such raw waters therefore should be one that will provide active viral inactivation.

Increasing problems with chlorination, such as high ammonia-N in the raw water and problems of viral inactivation, together with recent engineering improvements in ozonation, have suggested a growth of ozonation to 5 to 10 percent of water-supply undertakings within the next decade or so.

The advantages of using ozone are its high germicidal effectiveness, which is the greatest of all known substances, even against resistant organisms such as viruses and cysts; its ability to ameliorate many problems of odor, taste, and color in water supplies; and the fact that on decomposition the only residual material is more DO. In addition, its potency, like that of ClO_2, is unaffected by pH of ammonia content.

Morris, J.C.

Formation of Halogenated Organics by Chlorination of Water Supplies (A Review).

Harvard University, Cambridge, Mass., Department of Sanitary Chemistry, March 1975. 56p. (Available from National Technical Information Service (NTIS) as PB-241 511).

Key Words: synthetic/organics, chlorination.

Abstract:

The finding of product haloforms as a result of the chlorination of relatively unpolluted surface water supplies poses a serious problem for agencies producing domestic water supplies, for chlorination is the almost universal procedure used to protect against the water-borne transmission of infectious diseases. The problem lies not so much in the production of the haloforms themselves as it does in the possibility that other, unknown, highly toxic or carcinogenic compounds may also be produced simultaneously.

A careful review and assessment of available literature relating to the formation of chlorinated organic compounds under conditions prevailing in natural waters leads to the conclusion that chlorination is not indiscriminate, and so does not lead to the formation of all sorts of chlorinated derivatives with any and all organic pollutants. Rather it proceeds by a limited number of well-defined reactions on a few specific types of organic structures.

The identifiable initial reactions are electrophilic aromatic substitution of positive chlorine and electrophilic addition of positive chlorine to appropriately activated double bonds. The former reaction, which produces malodorous chlorophenolic compounds in intermediate stages, leads ultimately to oxidative ring rupture. The latter process leads to chloroform (and other haloforms when bromide is present) as the end product.

Direct substitution reactions of aqueous chlorine leading to the formation of exhaustively chlorinated hydrocarbons are unknown and unlikely. The known mechanisms do not lead to such exhaustively chlorinated products as carbon tetrachloride or tetrachloroethylene.

Reduction in the concentration of chlorinated organic compounds in finished municipal supplies can be achieved either by pretreatment methods to remove organic precursors or by post-treatment with activated carbon.

Morris, R.L., L.G. Johnson, and D.W. Ebert.

Pesticides and Heavy Metals in the Aquatic Environment.

Health Laboratory Science. 9:145-151. April 1972.

Key Words: DDT, DDE, dieldrin, surface water (fresh), fish.

Abstract:

Aldrin applied to row crops in Iowa is appearing as high levels of dieldrin in edible tissue of catfish but not in pan or predator fish. Research indicates that bottom silts and associated food chain organisms aggregate these pesticides carrying over from one year application period to another. Correlation between high turbidity or soil erosion and elevated muscle tissue dieldrin concentration indicates the necessity of improved soil conservation practices.

Methodology and concentrations of heavy metals in the water, bottom silts and aquatic organisms are presented.

Selective fish species concentration of mercury contrasted to pesticide aggregation is discussed.

Morris, R.L., A.J. Mearns, and J. Kim.

Viruses and Bacteria in Coastal Waters and Shellfish.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1976. pp. 97-104.

Key Words: viruses, coliforms, shellfish, surface water (marine).

Abstract:

Viruses can be detected in shellfish near outfalls and appear to survive relatively longer in mussels than do total coliforms. The majority of the mussel samples had total-coliform-to-virus ratios approximately 100 times lower than the average ratio for primary effluent. The relative time required for 90% of the viruses in seawater to be inactivated was estimated to be 3 to 6 times as long as that for total coliform.

Morrison, S.M., K.L. Martin, and D.E. Humble.

Lime Disinfection of Sewage Bacteria at Low Temperature.

Colorado State University, Fort Collins, September 1973. 102p. (Available from National Technical Information Service (NTIS) as PB-228 565).

Key Words: *Escherichia coli*, coliforms, bacteria, BOD, phosphates.

Abstract:

This article discusses lime treatment of wastewater for disinfection and nutrient removal.

Mosey, F.E. and D.A. Hughes.

The Toxicity of Heavy Metal Ions to Anaerobic Digestion.

Water Pollution Control. 74(1):18-39. 1975.

Key Words: zinc, cadmium, iron, copper, anaerobic digestion.

Abstract:

The following results are discussed:

1. The silver/silver sulphide electrode has been shown to be a reliable analytical tool for measuring pS values.

2. A pS value greater than 14.0 in a digesting sludge has been shown to indicate the presence of inhibitory concentrations of the heavy metal ions Zn^{++}, Cd^{++}, Fe^{++}, Cu^{+}, or Cu^{++} provided that oxidizing agents are absent.

3. The neutralization of zinc toxicity by precipitation of zinc as zinc carbonate requires a pH value of around 7.6.

4. The redox potential of healthy "balanced" digestion has been confirmed to be -265 ± 25 mV on Eh scale at pH values between 7.0 and 7.2, becoming about 57 mV more negative per unit increase in pH value.

5. Ferric ions have been shown to be reduced to ferrous ions, and cupric ions to cuprous ions, during anaerobic digestion.

6. The toxicity of chromium added as a hexavalent salt has been shown to be similar to that of the trivalent salt.

Mosley, J.W.

Transmission of Viral Diseases by Drinking Water.

In: Transmission of Viruses by the Water Route. G. Berg, ed.
Wiley, New York, 1965. pp. 5-23.

Key Words: hepatitis virus, drinking and recreational water.

Abstract:

Infectious hepatitis is the only viral disease which is known to be water-borne. Even though many water-borne epidemics are undoubtedly unrecognized, transmission of infectious hepatitis by drinking water appears to be a relatively infrequent occurrence. To say this is not to minimize its considerable importance from several standpoints.

1. It can be a problem of substantial or even disastrous magnitude. Good public health practices with regard to water supplies must be maintained at all times. Changes in natural conditions, faulty equipment, human negligence or human error can all result in epidemics.

2. The potential threat of water-borne hepatitis makes it necessary to consider the possible role of this route in every cluster of cases. While many water-borne epidemics end spontaneously, cases have sometimes continued until the situation was recognized and remedial action taken.

3. Each water-borne epidemic provides the opportunity to learn more about infectious hepatitis. Such epidemics have already been helpful in gathering new information about virus survival under natural conditions, variations in incubation period, age-specific attack rates and susceptibility in various socio-economic groups.

The available evidence does not permit us to assign any more important role to transmission of viruses by drinking water at the present time. There is a feeling, however, that water does have a more important role, especially in relation to municipal systems using surface water. Why should such a feeling exist if the evidence is no more adequate than we have found thus far? The author believes several reasons may be assigned.

1. With recognition of the increasing contamination of water sources by an expanding population increasingly concentrated in urban areas, there is a feeling that this much pollution must be producing a problem in terms of human disease. Since no such problem can be demonstrated

in relation to bacterial diseases, it is being sought for viral diseases.

2. The Delhi epidemic suggested that bacteriological standards may not be adequate with respect to safety from viruses, and this produces a feeling of insecurity.

3. If transmission of viral disease by municipal systems is occurring, the approach to the situation is simple. More intensive application of known methods of water purification could prevent whatever the number of resulting cases.

Mosser, J.L., T.Z. Teng, W.G. Walther, and C.F. Wurster.

Interactions of PCB's, DDT, and DDE in a Marine Diatom.

Bulletin of Environmental Contamination and Toxicology.
12:665-668. June 1974.

Key Words: DDT, DDE, chlorinated hydrocarbons, surface water (marine).

Abstract:

This paper begins to examine the interactions and the effect of these interactions upon marine diatoms. It suggests that when these contaminants are studied together they may have greater environmental impact than when studied separately. No data were available on uptake, but the article suggests it may be greater than believed.

Moyer, B.R. and T.F. Budinger.

Cadmium Levels in the Shoreline Sediments of San Francisco Bay.

University of California, Berkeley, Donner Laboratory and Lawrence Berkeley Laboratory, April 1974. 41p. (Available from National Technical Information Service (NTIS) as LBL-2642).

Key Words: cadmium, surface water (marine).

Abstract:

Cadmium levels in the low-tide shoreline sediments of San Francisco Bay were investigated at 68 locations. Sample cores of 5.5 cm diameter and 10 cm depth were separated into top and bottom fractions and analyzed for cadmium by atomic absorption spectrophotometry. The mean values of cadmium content in the top and bottom fractions (in dry soil) were 1.22 plus or minus 0.99 (0.06 to 4.69) microgram/g and 0.93 plus or minus 0.74 (0.14 to 3.91) respectively. The mean value for all the 10-cm cores of San Francisco Bay peripheral muds was 1.07 plus or minus microgram/g. Concentrations greater than 2 ppm suggest recent pollution; 13% of the samples were above this level.

Muellenhoff, W.P.

Preliminary Summary of Sludge Degradation Studies in a Marine Benthic Environment.

In: Pretreatment and Ultimate Disposal of Wastewater Solids.
A. Freiberger, ed. EPA-902/9-74-002, Environmental Protection Agency, Region II, New York, 1974. pp. 349-390.

Key Words: total organic carbon, surface water (marine).

Abstract:

Field and preliminary laboratory experiments have provided data on the decreases in sludge bed carbon concentrations and oxygen consumption rates. Further experiments are being devoted to better definition of initial carbon losses and documentation of carbon decreases in deeper beds. Measured significant losses of organic carbon upon settling the sludge through a sea water column are being better documented because of possible ramifications regarding disposal procedures. A conceptual mathematical model of sludge bed dissolved, particulate and gaseous carbon fractions is being formulated in an effort to better understand the mechanisms and transfer rates for carbonaceous materials in stabilizing sea floor sludges.

Decreases in sludge bed total carbon content (grams of carbon per gram solid) amounted to 71 to 68% respectively for 81 and 68 days experiments at 1 atmosphere. Sludges subjected to pressures of 6.8 and 34 atmospheres had a carbon content loss of approximately 30% in 47 days. Reaction velocity constants (K) of 0.006 and 0.007 for the pressure experiments were lower than for experiments at 1 atmosphere where K ranged from 0.010 to 0.046.

The in-situ oxygen consumption rate of an aerobically digested sludge ranged from 3.74 grams O_2/m^2/day to 2.0 g-O_2/m^2/day after 65 hours. For an anaerobically digested sludge the initial rate of 2.51 g-O_2/m^2/day in 70 hours.

Laboratory measurements with anaerobically digested sludges revealed significantly different oxygen consumption rates depending on the sludge source. Sludge from a local treatment plant had an initial uptake rate of 2.72 g-O_2/m^2/day which decreased to 0.95 g-O_2/m^2/day after 53 days.

Murphy, K.L.

Gamma Radiation as an Effective Disinfectant.

Water and Pollution Control. 112:(4):24-28. April 1974.

Key Words: coliforms, COD, total organic carbon, radiation treatment.

Abstract:

Disinfecting with radiation is discussed in this paper. Reduction effects on various microorganisms are presented.

Murtaugh, J.J. and R.L. Bunch.

Acidic Components of Sewage Effluents and River Waters.

JWPCF. 37(3):410-415. March 1965.

Key Words: synthetic/organics, COD, effluent characteristics.

Abstract:

The biological decomposition of complex organic matter can be shown to proceed through various biochemical intermediates. Significantly, the lower aliphatic acids appear as intermediate products regardless of whether the original substrate was carbohydrate, protein, or fat; however, the amount of each is related to the environmental conditions and the nature of the material undergoing decomposition.

The total volatile acid determination has long been used in the control of anaerobic sludge digestion. The possible interrelationship between organic acids and water quality has been recognized but somewhat hampered by the lack of sensitive quantitative analytical methods. With the development of gas chromatography, separations and determinations heretofore thought to be impossible now can be made. By using this new tool augmented by other methods adapted to waste samples, the lower aliphatic acids of effluents and rivers were determined.

This paper describes a workable procedure for the determination of volatile acids in dilute waste samples and the interrelationship of these acids in sewage effluents and rivers.

Mytelka, A.I., J.S. Czachor, W.B. Guggingo, and H. Golub.

Heavy Metals in Wastewater and Treatment Plant Effluents.

JWPCF. 45(9):1859-1864. September 1973.

Key Words: lead, nickel, cadmium, cobalt, chromium, copper, zinc, iron, manganese, mercury, influent characteristics, effluent characteristics, activated sludge.

Abstract:

This paper has described the findings of the Commission's routine heavy metals analyses of municipal wastewater treatment plants. The results show that many plants receive and discharge heavy metals above prudent limits. In order to minimize the harmful effects of these heavy metals (and of those not discussed in this paper), techniques must be implemented to achieve as close to 100 percent removal as possible before these metals enter the sewer system. This is especially important in the New York/New Jersey/Connecticut area, where combined sewer systems allow wastewater to by-pass treatment plants and discharge, untreated, directly into the receiving water ways.

Napolitano, P.J. and D.R. Rowe.

Microbial Content of Air near Sewage Treatment Plants.

Water and Sewage Works. 113(12):480-483. December 1966.

Key Words: coliforms, activated sludge, air, trickling filters.

Abstract:

The following conclusions are reached:

1. Activated sludge treatment plants yield approximately ten times as many coliform organisms as high rate trickling filters.

2. In activated sludge plants, the aeration tanks emit three times as many coliform organisms as other units in the plant.

3. In high-rate trickling filter plants, the trickling filters yield twice as many coliform organisms as other units of the plant.

4. The coliform count at increased distances from a source is a function of the wind velocity and decreases with distance.

5. Approximately 50 percent of the particulate matter given off at both types of plants is above five microns in diameter and, therefore, is nonhazardous to the lung.

National Emissions Inventory of Sources and Emissions of Chromium.

GCA Corp., Bedford, Mass., GCA Technology Division, May 1973. 41 p. (Available from National Technical Information Service (NTIS) as PB-230 034).

Key Words: chromium, influent characteristics, surface water (fresh).

Abstract:

A national inventory of the sources and emissions of the element chromium was conducted. The study included the preparation of an overall material flow chart depicting the quantities of chromium moving from sources of mining and importation through all processing and reprocessing steps to ultimate use and final disposition. All major sources of chromium-containing emissions were identified and their chromium emissions into the atmosphere estimated. A regional breakdown of these sources and their emissions was also provided. The physical and chemical nature of the chromium-containing emissions was delineated to the extent that information was available, and a methodology was recommended for updating the results of the study every 2 years.

Nebel, C., R.D. Gottschling, R.L. Hutchinson, T.J. McBride, D.M. Taylor, J.L. Pavoni, M.E. Tittlebaum, H.E. Spencer, and H. Fleischman.

Ozone Disinfection of Industrial-Municipal Secondary Effluents.

JWPCF. 45(12):2493-2507. December 1973.

Key Words: BOD, COD, total organic carbon, nitrates, phosphates, ozonation.

Abstract:

The pilot study has demonstrated that ozone can be successfully used as an alternative to chlorination for rapid disinfection and concurrent tertiary treatment of combined municipal-industrial secondary effluent. In most instances, earlier laboratory results have been equalled or surpassed.

Ozone brings about effluent quality improvement by a combination of direct oxidation and an ozone-induced flotation process. An ozone contact chamber of simple design allows efficient ozone transfer and froth removal without extensive pumping or mixing operations.

The ozonized effluent is non-toxic, high in dissolved oxygen content, and indistinguishable in appearance from potable water.

Ozone theoretically can oxidize organic materials completely to carbon dioxide and water. This would be reflected by a decrease in the total organic carbon (TOC) level of the effluent. This objective is realized at the Washington, D.C., Blue Plains ozone pilot plant where high ozone dosage levels are utilized for tertiary treatment. The limited data show the results of TOC analyses of Louisville effluents performed by the EPA's Taft Research Laboratory in Cincinnati. It is apparent that the 15 mg/l ozone dosage used in the pilot study is not large enough to cause a significant reduction of TOC by carbon dioxide evolution. The first products of ozone oxidation of organic molecules are oxygenated materials that are water soluble and not highly volatile.

Nelson, D.W., L.B. Owens, and R.E. Terry.

Denitrification as a Pathway for Nitrate Removal in Aquatic Systems.

Purdue University, Lafayette, Indiana, Water Resources Research Center, December 1973. 93p. (Available from National Technical Information Service (NTIS) as PB-231 305).

Key Words: ammonia, nitrates, nitrites, nitrification/denitrification.

Abstract:

Denitrification was determined by decrease in total nitrogen in a water media or by a decrease in N-15 labelled nitrate in sediment systems. It was established that the numbers of denitrifying bacteria, pH, and nitrate concentration of most surface waters will support denitrification. The process is inhibited by high dissolved oxygen and low dissolved organic carbon. Low temperature also restricts denitrification. River water samples exhibited denitrification when amended with glucose and nitrate under anaerobic conditions, whereas, pond waters did not. The findings indicated that denitrification in the water phase is insignificant to the nitrogen status of most streams and lakes. However, denitrification in sediments may result in a large removal of nitrate from aquatic systems each year.

Nelson, J.D. and R.R. Colwell.

The Ecology of Mercury-Resistant Bacteria in Chesapeake Bay.

Microbial Ecology. 1:191-218. 1975.

Key Words: mercury, bacteria, surface water (marine).

Abstract:

Total ambient mercury concentrations and numbers of mercury resistant, aerobic heterotrophic bacteria at six locations in Chesapeake Bay were monitored over a 17 month period. Mercury resistance expressed as the proportion of the total, viable, aerobic, heterotrophic bacterial population reached a reproducible maximum in spring and was positively correlated with dissolved oxygen concentration and sediment mercury concentration and negatively correlated with water turbidity. A relationship between mercury resistance and metabolic capability for reduction of mercuric ion to the metallic state was established by surveying a number of $HgCl_2$-resistant cultures. The reaction was also observed in microorganisms isolated by differential centrifugation of water and sediment samples. Mercuric ion exhibited an average half-life of 12.5 days in the presence of approximately 10^5 organisms/ml. Cultures resistant to 6 ppm of mercuric chloride and 3 ppm of phenylmercuric acetate (PMA) were classified into eight generic categories. Pseudomonas spp. were the most numerous of those bacteria capable of metabolizing both compounds; however, PMA was more toxic and was more selective for Pseudomonas. The mercury-resistant generic distribution was distinct from that of the total bacterial generic distribution and differed significantly between water and sediment, positionally and seasonally. The proportion of nonglucose-utilizing mercury-resistant Pseudomonas spp. was found to be positively correlated with total bacterial mercury resistance. It is concluded from this study that numbers of mercury-resistant bacteria as established by plate count can serve as a valid index of in situ Hg^{2+} metabolism.

Nelson, J.D. and R.R. Colwell.

Metabolism of Mercury Compounds by Bacteria in Chesapeake Bay.

Department of Microbiology, University of Maryland, College Park, 1973. 11p.

Key Words: mercury, surface water (fresh), surface water (marine).

Abstract:

Biological transformations of mercury in the environment have been identified, but neither the key agents nor the exact processes are well understood. Mobilization of mercury, as a part of the mercury "cycle" in nature, has been given attention because of an increasing mercury load in the environment with resultant hazards to human health, derived in part from microbial activity.

Mercury resistant bacteria isolated from Chesapeake Bay were capable of metabolizing phenylmercuric acetate (PMA) with the production of elemental mercury. The Pseudomonas spp. isolated were resistant to mercury compounds in general and were capable of adaptation to high levels of resistance to specific mercury compounds. The process of biomethylation of inorganic mercury and the observed "reductive decomposition" of organo mercury by mercury resistant marine bacteria may be responsible in part for mercury mobilization and subsequent detoxification of mercury polluted environments, as well as atmospheric transport of mercury.

The decomposition of PMA by a Pseudomonas species was found to be dependent upon adaptation to PMA and was magnesium ion dependent. From the pattern of PMA uptake by cells and effects of inhibitors of oxidative phosphorylation on the PMA metabolic process, it was concluded that degradation of PMA takes place on the cell surface, with production of predominantly inorganic volatile species of mercury.

Nelson, J.D., W. Blair, F.E. Brinckman, R.R. Colwell, and W.P. Iverson.

Biodegradation of Phenyl-Mercuric Acetate by Mercury-Resistant Bacteria

Key Words: bacteria, mercury, surface water (marine).

Abstract:

Selected cultures of mercury-resistant bacteria degrade the fungicide-slimicide phenylmercuric acetate. By means of a closed system incorporating a flameless atomic absorption spectrophotometer and a vapor phase chromatograph, it was demonstrated that elemental mercury vapor and benzene were products of phenylmercuric acetate degradation.

Neri, L.C., D. Hewitt, G.B. Schreiber, T.W. Anderson, J.S. Mandel, and A. Zdrojewsky.

Health Aspects of Hard and Soft Waters.

JAWWA. 67(8):403-409. August 1975.

Key Words: epidemiology, groundwater.

Abstract:

The relationship of waterborne minerals to the incidence of mortality is pursued. The article includes 575 Canadian Community Water Analysis data.

Mg^{++} appears to be the element that is most probably responsible for associations between cardiovascular mortality and water hardness.

Neubauer, W.K.

Waste Alum Sludge Treatment.

JAWWA. 60(7):819-826. July 1968.

Key Words: lime treatment.

Abstract:

Although the problem of sludge disposal from water treatment plants has existed for many years, very little has been done to solve it. It has been estimated that the solids resulting from municipal water treatment now total about 1,000,000 tons/year or one-tenth of the total quantity of waste from municipal wastewater treatment. This figure is not going to decrease.

This study has evaluated certain processes. Engineers of the Fylde Water Board of Lancashire, England, have successfully concentrated sludge by freezing. Tampa has operated a full scale process for the recovery and reuse of alum from sludge. Several water treatment plants dispose of sludge by discharge to sewage treatment plants. Other methods of disposal may have been investigated and certainly other methods are available. Every effort must be made to continue to attack this problem and develop economical processes that can be utilized on a full scale wherever needed.

Neufeld, R.D. and E.R. Hermann.

Heavy Metal Removal by Acclimated Activated Sludge.

JWPCF. 47(2):310-329. February 1975.

Key Words: cadmium, zinc, mercury, activated sludge.

Abstract:

The following conclusions were reached:

1. It is possible to maintain a thriving culture of activated biota in the presence of levels of mercury, cadmium, or zinc that are much higher than those previously thought possible.

2. Kinetic parameters from Michaelis-Menten types of equations, which describe the metabolic rates of the organisms, have been evaluated at several heavy metals concentrations. For cadmium and zinc, these parameters were found to be virtually constant until a threshold concentration of metal in sludge was reached. It was established that, beyond this threshold, the parameters will vary in a linear fashion when values of the parameters are plotted relative to metal in floc concentrations on log-log paper. No threshold effect was observed in the case of mercury.

3. The mechanism of inhibition of respiration for mercury seems different from that for cadmium and zinc, the latter two differing only in magnitude. Mercury affects the metabolic rate in a way that may be totally counteracted by increasing the concentration of organic substrate. As the cadmium or zinc concentration increases beyond the observed threshold, however, the maximum obtainable metabolic rate decreases and cannot be further reinstated by increasing the substrate level.

4. The ratio of the weight of metal in the biological floc phase to the weight of metal in the surrounding aqueous phase for the metals mercury, cadmium, and zinc at equilibrium conditions ranges from 4,000 to 10,000 times.

5. Mercury, cadmium, and zinc are rapidly removed from aqueous solutions by biological floc. Although eventual equilibrium was achieved after about 2 wk of contact, 3 hr of contact were sufficient to achieve an almost complete approach to that equilibrium.

New Process Detoxifies Cyanide Wastes.

Environmental Science and Technology. 5(6):496-497. June 1971.

Key Words: cyanides, chemical treatment.

Abstract:

Recently, E.I. du Pont de Nemours and Co. has introduced a novel process which should appeal primarily to small plant operators using cyanide baths to plate zinc or cadmium onto ferrous metals. Called the Kastone process, it oxidizes cyanide from plating wastes to cyanates and simultaneously precipitates zinc or cadmium complexes which can be removed by simple filtration.

Newton, C.D., W.W. Shephard, and M.S. Coleman.

Street Runoff as a Source of Lead Pollution.

JWPCF. 46(5):999-1000. May 1974.

Key Words: lead, combined municipal and/or storm systems.

Abstract:

This paper predicts that the average concentration of lead in street runoffs will be 0.23 mg/l.

Ng, Y.C., W.L. Robinson, and D.W. Wilson.

Modeling Radiation Exposure to Population from Radioactivity Released to the Environment.

Lawrence Livermore Laboratory, Livermore, California, 1973. 24p.

Key Words: aluminum, antimony, arsenic, barium, baryllium, boron, cadmium, chromium, cobalt, copper, germanium, lead, iron, manganese, mercury, molybdenum, nickel, selenium, thorium, tin, uranium, zinc, fish, shellfish.

Abstract:

This article discusses concentration mechanisms in aquatic organisms.

Nickerson, G.L., C.M. Robson, R.D. Morrison, and R.C. Clinger.

Chemical Addition to Trickling Filter Plants.

JWPCF. 46(1):133-147. January 1974.

Key Words: suspended solids, BOD, trickling filters, chemical treatment.

Abstract:

The following conclusions have been derived from the work presented in this paper:

1. Chemical addition ahead of the primary clarifiers, coupled with hydraulic modifications, has been shown to increase overall BOD and SS removals at two Fairfax County trickling filter wastewater treatment plants operated at flows in excess of their nominal design capacity. In these instances, the main objective was the removal of oxygen demanding materials. A side benefit of using ferric chloride as a coagulant was the removal of significant quantities of phosphorus.

2. Enhancing treatment efficiency with chemical addition is essentially an interim solution, because the continuous application of chemicals to the liquid stream and in the sludge handling system creates an extremely high operating expense.

3. Increased sludge handling problems may be expected when chemical addition to the liquid stream is practiced for increased removal of oxygen demanding materials. Existing sludge handling facilities should be carefully reviewed for adequacy; any necessary improvements should be made before liquid stream chemical addition. Further, addition of chemicals to the sludge handling system may be required to enhance thickening and dewatering operations.

4. Serious hydraulic problems of an overloaded plant should be corrected or minimized at the same time, or before, chemical coagulation is implemented.

5. In light of the results achieved, the magnitude of flow through a particular plant is irrelevant if raw wastewater is not bypassed and the treatment processes remove sufficient pollutants to satisfy the permit issued by the regulatory agencies.

6. Successful chemical treatment procedures or modes of operation at one plant may or may not be successful when applied to another. This is true even though both plants

may be in the same locale, receive similar influent wastes, and have almost identical flow configurations and basic treatment processes.

7. Chemical coagulation treatment can only be optimized at any particular plant with experience gained under actual plant scale operational conditions. Jar testing is not always predictive of plant scale operations.

8. Personnel at overloaded treatment plants undergo extreme hardships during initial operation with chemical addition, but, with time, adjust and overcome most operational difficulties.

9. Successful operation of a chemical addition system depends, to a large extent, on the competence and conscientiousness of the treatment plant operating personnel. In the final analysis, it was their diligence that, in this case, determined the outcome of the Interim Pollution Abatement Program.

10. The accomplishment of the portion of Fairfax County's pollution abatement program presented in this report was the result of a joint effort. The county board of supervisors recognized the immediate nature of the situation and authorized the Interim Pollution Abatement Program. The consultant, Engineering-Science, Inc., was able to meet the challenge and provide a feasible treatment method that could be incorporated quickly into the existing treatment plant flow scheme with minimum capital expenditures. The operators of each plant responded to the problems of overload facilities as well as new processes and equipment and never failed to overcome seemingly insurmountable operating problems.

Nimmo, D.R., J. Forester, P.T. Heitmuller, and G.H. Cook.

Accumulation of Aroclor 1254 in Grass Shrimp (*Palaemonetes pugio*) in Laboratory and Field Exposures.

Bulletin of Environmental Contamination and Toxicology.
11:303-308. November 1974.

Key Words: chlorinated hydrocarbons, shellfish.

Abstract:

The accumulation here is in the magnitude of 10^3.
The author studied the accumulation of Aroclor 1254 by grass shrimp and found it to be in the order of magnitude of 10^3.

Nisbet, I.C.T.

Criteria Document for PCB's.

Massachusetts Audobon Society, Lincoln, Massassachusetts, July 1976. 624p. (Available from National Technical Information Service (NTIS) as PB-255 397).

Key Words: chlorinated hydrocarbons, surface water (fresh), surface water (marine), groundwater, crops, livestock, fish.

Abstract:

This is a review of the chemical and physical properties, toxic effects, and environmental fate of PCB's. Topics discussed include effects on humans; transport; fate; bio-accumulation in fish, shellfish, birds, mammals (including cows and pigs), and humans; levels in freshwater lakes and rivers, marine environments, municipal and industrial effluents, interactions of PCB's with soils; occurrence in foodstuffs (including meat, grains, dairy products, etc.).

Nisbet, I.C.T. and A.F. Sarofim.

Rates and Routes of Transport of PCB's in the Environment.

Environmental Health Perspectives. 1: 21-28. April 1972.

Key Words: chlorinated hydrocarbons, surface water (fresh), surface water (marine), fish.

Abstract:

According to the estimates made in this paper, the PCB's released into the North American environment in the past are now concentrated in three major compartments in the environment: (a) buried in landfill dumps (roughly $3x10^5$ tons, without allowing for degradation); (b) attached to sediments in rivers and the Great Lakes (roughly $2x10^4$ tons); (c) attached to sediments on the continental shelf (roughly 10^4 tons). A further substantial quantity (of the order of $2x10^4$ tons) has been widely distributed over the land and sea by aerial fallout and by disposal from ships. All the numerical estimates are expected to be valid to order of magnitude only.

Transfer of PCB's within the environment is expected to take place by the following main routes: (a) volatilization, aerial transport on particulates, and fallout; (b) leaching from dumps; (c) sediment transport in rivers and in the shallow sea; (d) sedimentation in the ocean. Uptake and transport by the biota is probably a quantitatively unimportant route of transfer of PCB's but is of major biological significance. Virtually no evidence is available on the rate of transport by any of these routes, but it is expected that all are very slow. In particular, PCB's in sediments in rivers and lakes are likely to move downstream and augment those in the shallow sea for a long period into the future.

Nitrates, Nitrites, and Methomoglobinemia; Report Prepared by Douglas H.K. Lee.

In: Environmental Review No. 2. National Institute of Environmental Health Sciences, Research Triangle Park, N.C., May 1970. pp. 19-29.

Key Words: nitrates, surface water (fresh), groundwater.

Abstract:

The following actions are suggested:

1. Continued improvement in protection of wells from contamination by surface water containing nitrogenous material.

2. Increased systematic sampling of rural well waters and plain identification of those that exceed recommended limits.

3. Continuing surveillance of wells in areas where the water table is rising, seasonally or continuously, to the point that deposited nitrates are likely to be mobilized.

4. Periodic reminder to communities dependent on nitrate-containing well waters about the dangers to infants.

5. Critical research into the possibility of formation of carcinogenic nitrosamines and allied substances in cured meats.

Nitrification and Denitrification Facilities: Wastewater Treatment.

U.S. Environmental Protection Agency, Washington, D.C., August 1973. 33p.

Key Words: ammonia, nitrates, nitrites, nitrification/denitrification.

Abstract:

In this paper a nitrification pilot plant is described in detail and conclusions concerning nitrification kinetics, design of nitrification systems and denitrification by suspended growth systems are discussed. The aim of the paper is to demonstrate how wastewater-treatment plants can be designed to accomplish both nitrification and denitrification.

Nitrogenous Compounds in the Environment.

U.S. Environmental Protection Agency, Washington D.C., Hazardous Materials Advisory Committee, December 1973. 189p. (Available from National Technical Information Service (NTIS) as PB-232 959).

Key Words: ammonia, nitrates, direct contact, surface water (fresh).

Abstract:

This report is a series of papers on the sources and methods of control and the environmental and health effects of nitrogenous compounds. Diverse aspects of municipal and industrial sources are discussed--waterborne, atmospheric, agricultural, and industrial processes generating nitrogenous compounds. Attention is given to nitrogenous materials in waste and surface waters, efficiency of sewage treatment, effectiveness of the conventional BOD test, and the contribution of urban runoff and landfill leakage to the overall nitrogen load in the environment. Concentrations, sources, sinks, the transformation of nitrogenous materials in the lower atmosphere, control measures for stationary and mobile sources, retrofit systems for used cars, and new engine systems are reviewed. Plant nutrients, including fertilizers, and animal wastes are considered. The growing problems resulting from concentrated centralized livestock feedlots and methods of control are pointed out.

Nitrogen is discussed as a nutrient essential to living organisms and as a toxicant within the aquatic environment. The carcinogenicity of nitrosamines and their precursors is described as a potential danger to health.

Individual nitrogenous compounds are appropriately identified throughout the report. Analytical procedures for the identification and quantification of nitrogenous compounds are reviewed.

As presented to the Environmental Protection Agency in this report, the statement of the Hazardous Materials Advisory Committee presents the major concerns regarding nitrogenous compounds in the environment as these relate to the following Agency activities: research, monitoring, and regulation.

Noland, R.F. and R. Birkbeck.

Two-Stage Biological Process Provides High Degree of Treatment.

Presented at the 1973 Water Pollution Control Conference,
Cleveland, Ohio. 13p.

Key Words:· BOD, activated sludge.

Abstract:

This paper presents data and discusses the effectiveness of a two-stage biological process in providing treatment for concentrated organic waste. The results are very close to achieving the effluent requirements currently being imposed in Ohio's BOD and suspended solids of 7 and 7 mg/l, to maintain stream water quality at the desirable level. Two-stage biological treatment followed by tertiary lagoons can treat a strong organic wastewater and achieve a high degree of removal.

Nomura, M.M. and R.H.F. Young.

Fate of Heavy Metals in the Sewage Treatment Process.

Water Resources Research Center Technical Report No. 82.
University of Hawaii, Honolulu, September 1974. 31p.

Key Words: aluminum, cadmium, copper, iron, lead, mercury, zinc, activated sludge.

Abstract:

Heavy metals have long been known to exert toxic effects upon plants and animals at all trophic levels. Through the use of water as a cleansing and transporting agent, various types and forms of metals find their way into the sewerage system.

The step-aeration activated sludge treatment process removed most of the heavy metals, Al, Cd, Cu, Fe, Hg, Pb, and Zn, that were detected in concentrations ranging from a few parts per billion of mercury to a few parts per million of iron. Hexavalent chromium was removed somewhat less efficiently and nickel was reduced in concentration only slightly compared to the other metals monitored.

Results of this investigation showed that most of these metals were removed by precipitation with the sludges in primary treatment and further removal occurred through biological uptake in the secondary phase of treatment.

The residual concentration of metals in the final effluent discharge were usually below toxic levels, with the exception of nickel, for freshwater aquatic organisms and plants.

Trace amounts of Cd, Cr, Cu, Hg, Ni, and Pb were found in the raw sewage. Al, Fe, and Zn were the most abundant metals and from examination of discharge patterns, are attributable to domestic sources.

Total concentrations of these nine metals in the influent sewage did not exceed threshold toxicity levels to aerobic and anaerobic systems as reported by others.

Most of the Hg, Fe, Al, and Cu in the raw sewage were removed by the secondary treatment process. Pb and Zn removals were slightly less than those for the abovementioned metals while Cd, Cr (VI), and Ni exhibited low removals.

Norman, C.

The Little Nipper Who Cost the South a Fortune.

Nature. 255(5504):94-95. May 8, 1975.

Key Word: epidemiology.

Abstract:

About 10,000 people a year are treated for fire-ant stings in Alabama, Georgia, and Mississippi. This article discusses the use of mirex to control fire-ants.

Norman, N.N. and P.W. Kabler.

Stream Pollution: Bacteriological Study of Irrigated Vegetables.

Sewage and Industrial Wastes. 25:605-609. 1953.

Key Words: coliforms, salmonella, shigella, groundwater, crops.

Abstract:

1. The coliform content of irrigated soils studied reflects, in general, the coliform density of the water they receive.

2. Vegetables irrigated with waters of high coliform count exhibit a higher coliform flora than vegetables irrigated with relatively pure water.

3. The coliform density of leafy vegetables irrigated with polluted water is higher than smooth vegetables grown under similar conditions.

4. Under the condition of this study, the enterococcus indices of soils and vegetables showed no direct relationship to the indices of irrigational waters.

5. Salmonella were present in the irrigation waters in readily demonstrable numbers, were present in soils in only low concentration, and were insufficiently numerous on the vegetables to be demonstrated by the procedures used.

Norvell, W.A.

Equilibria of Metal Chelates in Soil Solution.

In: Micronutrients in Agriculture. R.C. Dinauer, ed. Soil Science Society of America, Madison, Wisconsin, 1972. pp. 115-138.

Key Words: iron, manganese, zinc, copper, boron, ponding/ land application, land reclamation.

Abstract:
The calculations and stability diagrams presented in this report summarize a portion of our knowledge concerning metal chelate equilibria in soils. Hopefully, this treatment will contribute to a rational basis for (1) understanding the simultaneous equilibria of chelating ligands and metal ions in soil solutions, (2) selecting chelating agents for use as micronutrient metal sources, and (3) estimating potential hazards from chelation of heavy metals by chelating agents added to soils in fertilizers or in effluents from waste treatment systems.

As our understanding of the equilibria of metal chelates in soils increases, equilibrium calculations and stability diagrams can help us to organize our knowledge and quantify many important relationships. However, additional knowledge will obviously require additional study of the chemistry of metals and chelating ligands in soils. Research to improve our quantitative understanding of the solubility of micronutrient and heavy metals in soils is urgently needed. Much of this information will undoubtedly come from careful studies of the equilibria of selected chelating agents in soils.

Another important objective is accurate stability constant information for both natural and synthetic chelating agents. For example, better stability constants for metal chelates formed by P_2O_7 and P_3O_{10}, particularly their Al^{3+} and Fe^{3+} chelates, would contribute significantly to our understanding of the chelating properties of these important fertilizer materials.

An especially important objective is identifying and characterizing the metal complexes formed by soluble organic matter in soil solution. These natural complexes undoubtedly control the mobility and availability of many metals in soils.

Agronomic interest in metal chelates as micronutrient sources continues, and concern with the solubility and mobility of heavy metals is increasing. Consequently, studies of the equilibria between metals and chelating ligands in soils should continue to merit our interest and support.

Novak, J.T. and J.H. O'Brien.

Polymer Conditioning of Chemical Sludges.

JWPCF. 47(10):2397-2410. October 1975.

Key Words: suspended solids, gravity thickeners.

Abstract:

Based on the data collected in this study, the following conclusions may be drawn:

1. High-molecular weight organic polymers improve sludge dewatering by decreasing the sludge specific resistance.

2. High-molecular weight organic polymers increase the sludge compressibility but have little effect on the filter cake solids concentration.

3. A linear relationship was found between the optimal polymer dose and sludge solids concentration. Differences in sludge polymer dose requirments were caused by sludge pH and filter cake solids concentration variations.

4. The polymer dose requirements decreased as polymer molecular weights increased. At molecular weights below 1×10^6, polymers were ineffective for chemical sludge conditioning.

5. Polymers respond to sludge pH variations. Nonionic to moderate-activity anionic polymers function well between pH 6 and 8.5. High-activity anionics function well at pH levels above 8.5. Cationic polymers perform best at neutral to slightly acidic pH's.

Nupin, E.M.

Virus Studies on the Windhoek Wastewater Reclamation Plant (South-West Africa).

Water Research. 4:661-672. 1970.

Key Words: viruses, gravity separators, ponding/land application, chlorination, chemical treatment.

Abstract:
The TCID$_{50}$ (50 percent tissue culture infective dose) method was found to be superior to the PFU (plaque forming unit) method for the detection and evaluation of viruses in sewage. Parallel statistical testing of the two-phase polymer separation method and of the alginate ultrafiltration method for the quantitative concentration of viruses in water samples showed comparable concentration and recovery of virus.

These methods of concentration proved effective in the testing of the virus removal by the advanced wastewater treatment plant at Windhock. Although enteroviruses and reovirus entered the sewage purification plant at levels as high as 20,000 TCID$_{50}$ per litre, no virus could be recovered from the finally treated water.

Nupin, E.M., B.W. Bateman, and N.C. McKenny.

The Reduction of Virus by the Various Unit Processes Used in the Reclamation of Sewage to Potable Waters.

In: Virus Survival in Water and Wastewater Systems. J.F. Malina, Jr., and B.P. Sagik, eds. University of Texas at Austin, Center for Research in Water Resources, 1974. pp. 107-114.

Key Words: viruses, activated sludge, chemical treatment, adsorption/ion exchange.

Abstract:

A unique multiple system plant in Windhoek, South West Africa, which reclaims drinking water from a sewage works effluent, has been regularly monitored for virus removal since its commissioning in 1968. This information, and that obtained in laboratory and pilot plant investigations, contributed to the construction of the experimental Stander Reclamation Plant in Pretoria. This plant is designed to treat a million gallons a day and is being used to study the efficiency of various unit processes for the advanced purification of sewage.

This report deals with the removal and inactivation of certain enteroviruses in conventional sewage purification, maturation ponds, and each relevant individual unit process of the above plants. In laboratory studies on the mechanisms of the effects of treatment processes on viruses, special attention has been given to powdered activated carbon adsorption and chlorination.

Nusbaum, I. and R.M. Garver.

Survival of Coliform Organisms in Pacific Ocean Coastal Waters.

Sewage and Industrial Wastes. 27(12):1383-1390. December 1955.

Key Words: bacteria, coliforms, surface water (marine).

Abstract:

A high degree of uncertainly still prevails with respect to the viability of enteric organisms in sea water. Even less is known on the fate of pathogens in the sea than on the tracer organisms commonly used.

Existing information must be re-evaluated with respect to the environment in which the experiments were conducted. These studies have shown that significant differences exist with respect to the treatment given the waters used, the source of the test organisms and the container in which the experiments were conducted. Sea water alone is not antagonistic to coliform organisms because of its salinity.

Under the conditions of the experiments in this study, coliform organisms have been found to persist in sea water for relatively long periods. Additional data are required comparing the effects of dispersal of bacteria containing wastes into fresh as well as sea water. It has been demonstrated in many instances, that the viability of enteric organisms in fresh water is not appreciably greater than sea water and may actually be less.

Ockershausen, R.W.

Alum vs. Phosphates: It's No Contest.

Water and Wastes Engineering. 11:54-61. November 1974.

Key Words: phosphates, BOD, suspended solids, chemical treatment.

Abstract:

This article discusses the removal of phosphate by chemical treatment.

Ockershausen, R.W.

In-plant Usage Works and Works.

Environmental Science and Technology. 865:420-423. May 1974.

Key Words: phosphates, BOD, suspended solids, chemical treatment, trickling filters.

Abstract:

This article, general in nature, discusses the upgrading of trickling filter plants by chemical addition and gives examples of how this has been accomplished.

O'Connor, G.A. and J.V. Anderson,

Soil Factors Affecting the Adsorption of 2, 4, 5-T.

Soil Science Proceedings. 38:433-436. May 1974.

Key Words: herbicides, groundwater.

Abstract:

Factors expected to affect the adsorption of 2, 4, 5-T on four soils of the western U.S. were studied. Organic matter was an important contributor to 2, 4, 5-T adsorption and in some soils was the only adsorbent of significance. Oxides of Fe and Al did not contribute much to adsorption in the soils studied although the pH of soils studied was only slightly acidic to alkaline.

O'Donnell, C. and F. Keith, Jr.

Centrifugal Dewatering of Aerobic Waste Sludges.

JWPCF. 44(11):2162-2171. November 1972.

Key Words: suspended solids, centrifugal thickeners.

Abstract:

This is a general discussion of the operational aspects of centrifugal dewatering of sludges.

O'Farrell, T.P., F.P. Frauson, A.F. Cassel, and D.F. Bishop.

Nitrogen Removal by Ammonia Stripping.

JWPCF. 44(8):1527-1535 August 1972 .

Key Words: ammonia, nitrification/denitrification .

Abstract:

Air stripping of ammonia in crossflow cooling towers with water temperatures of 80°F (26.6°C) removed 90 percent of the ammonia from a non-nitrified, lime-clarified secondary effluent at pH 11.5 with 500 cu ft air/gal liquid (3,750 l/l). At pH 11.5, heavy calcium carbonate scale was produced within the tower from the CO_2 in the air and the excess Ca^{2+} in the water at a rate of approximately 125 mg/l $CaCO_2$. The scale reduced air rates, which lowered the efficiency of ammonia removal, removed calcium carbonate needed for slurry pool stability in the clarification system and caused severe maintenance problems.

Operation of the air stripping system with effluent from the second-stage clarifier (pH 10.5) reduced the calcium carbonate scale rate to 16 mg/l $CaCO_2$. The decrease in pH of the influent to the stripping tower from 11.5 to 10.5 reduced the efficiency for ammonia removal by approximately 6 percent. Further reduction of the pH of the influent to 9.7 reduced the efficiency, as compared to pH 11.5, by approximately 34 percent.

The efficiency of the tower depended on air temperature, with a decrease in air temperature from 80° to 43°F (26.6° to 5.5°C) reducing the efficiency of ammonia removal by approximately 30 percent for air to liquid rates from 100 to 500 cu ft air/gal liquid (750 to 3,750 l/l). In addition, freezing occurred when the wet-bulb temperature within the tower reached 32°F (0°C), which resulted in the shutdown of the system.

Olaxsey, R. A.

Thermal Degradation of Sludges.

In: Pretreatment and Ultimate Disposal of Wastewater Solids. A. Freiberger, ed. EPA-902/9-74-001, Environmental Protection Agency, Region II, New York, 1974. pp. 127-196.

Key Words: incineration, wet air oxidation, heat treatment.

Abstract:

For the disposalist who must deal daily with the output of the sludge factory, thermal processing of sewage sludge is a disposal option that should be approached objectively. For smaller communities sludge combustion will most probably be the most expensive disposal technique. Large cities that are faced with the prospect of transporting sludge long distances to land disposal sites may find combustion to be a more attractive venture. The aesthetic and convenience advantages of on-site disposal must be weighed against the environmental, fuel-consumptive, cost aspects of incineration. Improvements in or alternatives to the sludge incineration process may, in the near future, solve all the problems associated with current thermal processing techniques, but since each new development also produces its own new problems, life promises to remain interesting in the realm of sludge disposal.

Oliver, B.G., J.B. Milne, and N. La Barre.

Chloride and Lead in Urban Snow.

JWPCF. 46(4):766-771. April 1974.

Key Words: chlorides, lead, groundwater, surface water (fresh), combined municipal and/or storm system, effluent characteristics.

Abstract:

The snow dump particulates were found not only to absorb lead with vigor but also to hold onto the lead tenaciously. Two grams of three typical particulate samples, obtained by filtering snow from dump sites, were shaken for 2 days with 20 ml of several solutions. The results are shown in Table IV. It is quite evident that over a pH range wider than that found in the natural environment (1.88 - 10.6), only a small percentage of the lead in the particulates was solubilized. Even at chloride levels as high as those of seawater, little lead was desorbed from the particulate. Strong NH_4Ac and $CaCl_2$ solution, used primarily in cation exchange studies, had little effect. Clearly, the lead is firmly bound to the particulates.

Analysis of the snow dump and storm sewer runoff and wastewater effluent in Table II showed that most of the lead in these samples is in the form of suspended solids. The levels of lead in these samples indicate that a significant portion of the lead generated in the city finds its way into the rivers where it is present primarily in the sediments.

Oliver, J.D. and R.R. Colwell.

Computer Program Designed to Follow Fluctuations in Microbial Populations and Its Application in a Study of Chesapeake Bay Microflora.

Applied Microbiology. 28(2):185-192. August 1974.

Key Words: bacteria, surface water (marine).

Abstract:

A computer program has been developed which performs cluster analysis of microorganisms using methods of numerical taxonomy. The program is designed to group related strains, identify the groups by reference to known strains, and calculate a hypothetical median organism (HMO) to each group. The HMO serves to condense taxonomic information and provides a tag for each strain cluster. Every strain in a group is compared with the HMO established for that group. A representative strain for the group is obtained by selection of the strain showing highest similarity to the HMO. New data sets can be compared with data sets of previous analyses. Hence, the occurrence of the same taxonomic groups within separate data sets can be determined. Quantitative or qualitative differences in distribution of taxonomic groups within or between data sets can be measured. The output from the computer is a graphical display, using an on-line plotter; thus, the investigator is provided with visual comparison of data sets. Results obtained from a study applying the computer program in an analysis of taxonomic data obtained for 43 bacterial strains isolated from Chesapeake Bay indicate the usefulness of this method of taxonomic analysis in microbial ecology.

Oliver, J.D. and R.R. Colwell.

Extractable Lipids of Gram-Negative Marine Bacteria: Fatty-Acid Composition.

International Journal of Systematic Bacteriology. 23(4):442-458. October 1973.

Key Words: bacteria, Vibrio cholerae, surface water (marine).

Abstract:

Fatty-acid compositions were determined for 20 strains of marine and estuarine bacteria and two strains representative of terrestrial species. Results showed that the fatty acids of marine bacteria differed little from those of nonmarine organisms, and a primary role for hexadecenoic acid was indicated. Of the 20 strains examined, with the exception of one, the major fatty-acid species were C16, C16:1, and C18:1. Significant differences were observed among the fatty-acid patterns of the various bacterial genera included in the set of 20 strains examined, and rapid differentiation of most of the genera could thus be accomplished. A recently isolated marine species demonstrated a unique fatty-acid pattern wherein branched acids formed the major fatty-acid class. Effects of culture age, growth temperature, and salt concentration of the medium on the fatty-acid profiles were also investigated.

Oliver, J.D. and R.R. Colwell.

Extractable Lipids of Gram-Negative Marine Bacteria: Phospholipid Composition.

Journal of Bacteriology. 114(3):897-908. June 1973.

Key Words: bacteria, surface water (marine).

Abstract:

Phospholipid compositions of 20 strains of marine and estuarine bacteria were determined. Results showed that phospholipids of marine bacteria differed very little from those of nonmarine organisms with phosphatidylethanolamine, phosphatidylglycerol, and diphosphatidylglycerol being the predominant phospholipids in all strains examined. Lyso-phosphatidylethanolamine occurred in significant quantities among a number of the marine bacteria, and two of the isolates contained significant quantities of poly-B-hydroxybutyrate. Effects of age and growth temperature on the phospholipid composition were also investigated. It is suggested that phylogenetic relationships among bacteria may be correlated with phospholipid composition.

Oloffs, P.C., L.J. Albright, S.Y. Szeto, and J. Lau.

Factors Affecting the Behavior of Five Chlorinated Hydrocarbons in Two Natural Waters and Their Sediments.

Journal of Fisheries Research Board of Canada. 30:1619-1623. November 1973.

Key Words: DDT, DDE, chlorinated hydrocarbons, surface water (fresh), surface water (marine).

Abstract:

Water samples from the Fraser River and Georgia Strait, British Columbia were treated with different chlorinated hydrocarbons and incubated for up to 12 weeks at 13 C.

1. In the presence of bottom sediments from the same locations as the waters, no residues were found to escape into the atmosphere.

2. With the exception of lindane in ocean water, all detectable residues had moved into the sediments after 6 weeks.

3. Most of the lindane was metabolized.

4. Sterilization of the waters and sediments prevented the metabolism of lindane but had little effect on DDT and DDD.

5. Agitation of water samples containing γ-chlordane, incubated without sediment, had no effect on its disappearance, but the presence of 0.01% of a nonionic surfactant retarded this almost completely.

Oloffs, P.C., L.J. Albright, and S.Y. Szeto.

Fate and Behavior of Five Chlorinated Hydrocarbons in Three Natural Waters.

Canadian Journal of Microbiology. 18:1393-1398. August 1972.

Key Words: DDT, chlorinated hydrocarbons, surface water (fresh), surface water (marine).

Abstract:

Water samples removed from two rivers and from the subtidal zone of Georgia Strait in British Columbia were treated with either 0.025 ppm of DDT, lindane, α-chlordane, or γ-chlordane, or 0.1 ppm Aroclor 1260 (PCB). The samples were incubated in the laboratory for up to 12 weeks at the temperatures of these natural waters at the time of sampling. Lindane persisted in all water samples throughout the experiment, but large proportions of the other compounds were transported into the atmosphere during incubation except when the containers were sealed. No metabolic breakdown could be demonstrated. As demonstrated with ^{14}C-γ-chlordane, uneven distribution of the pesticides occurred rapidly, but was prevented, or reversed, by addition of a surfactant to the water. Total bacterial counts were generally higher in treated than in untreated water samples.

Olsen, S.R.

Micronutrient Interactions.

In: Micronutrients in Agriculture. R.C. Dinauer, ed.
Soil Science Society of America, Madison, Wisconsin, 1972.
pp. 243-264.

Key Words: iron, manganese, zinc, copper, boron, ponding/land application, land reclamation.

Abstract:

This review of the literature emphasizes the complex nature of the relations between plant growth, nutrient concentration in solution, and nutrient concentration within the plant. Growth depends on many interacting factors such as nutrient supply, rate of nutrient absorption, distribution of the nutrient to functional sites, and nutrient mobility within the plant. Much progress has been made, especially toward better descriptions of the nature of the problems and the connections between interacting factors.

Future trends probably will be directed toward elucidating the mechanisms responsible for micronutrient interactions at molecular and cellular levels. For example, there is a need to identify those areas or sites within the plant where Fe and Zn are metabolically active and where excessive P concentrations may interfere with the maximum activity of these nutrients. Gross analyses of leaves, stems, and roots for Fe and Zn probably will not be sufficient to interpret the interactions with P. Absorption processes at the root surfaces connected with the interactions between the root and the soil offer fruitful approaches of investigation. Probably there is much important knowledge to be gained about the role of the HCO_3^- ion in nutrient absorption processes.

Plant species and varieties are known to vary in their susceptibility to Fe and Zn deficiencies, to interactions of P with Fe and Zn, and of Zn with Fe and other micronutrients. Careful studies of species and varietal differences have not been made under uniform conditions or in relation to environmental effects. Such studies offer an exciting promise that plants can be changed to fit the soil and that the soil environment can be changed to provide a medium for better growth of the plant.

Olson, K.R., H.L. Bergman, and P.O. Fromm.

Uptake of Methyl Mercuric Chloride and Mecuric Chloride by Trout: A Study of Uptake Pathways into the Whole Animal and Uptake by Erythrocytes in Vitro.

Journal of Fisheries Research Board of Canada. 30:1293-1299. September 1973.

Key Words: mercury, fish.

Abstract:

Twenty-four hour uptake rate of either $^{203}HgCl_2$ or $CH_3{}^{203}HgCl$ by rainbow trout (Salmo gairdneri) was not affected by esophageal ligation. Uptake of these two mercurials in non-feeding trout appears to be by way of the gills. Methyl mercury enters the fish at a faster rate than the inorganic form and anomalous tissue distribution of these two mercurials suggests that inorganic mercury does not require methylation prior to entry into the fish.

In vitro experiments using radioactive mercurials demonstrated high affinity of methyl mercury for red cells (up to 90% was bound to red cells in 40 min.). Only 9% of inorganic mercury was taken up by red cells, but, this percentage was increased up to 65% if the cells were washed and suspended in Ringer solution prior to incubation with mercury.

Olson, L.L. and C.D. Binning.

Interactions of Aqueous Chlorine with Activated Carbon.

In: Chemistry of Water Supply, Treatment, and Distribution. A.J. Rubin, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1975. pp. 253-295.

Key Words: chlorides, adsorption/ion exchange.

Abstract:

The removal of aqueous chlorine from solution using activated carbon is a two-part process, each having its characteristic rate of removal. Chloride production occurs only in Part I, while in Part II, the chlorine is "fixed" or combined with the activated carbon. Proton production occurred in both Parts I and II, but the largest portion of protons was produced in Part I. Concurrent with the production of chlorides and protons in Part I, surface oxides are formed on the activated carbon surface. The chlorine is "fixed" or combined with the activated carbon in Part I, and the activated carbon is also broken down and solubilized under certain conditions.

The rate of removal of aqueous chlorine using activated carbon in Park II of the removal process is inversely proportional to the amount of aqueous chlorine removed in Part I. The reason for this has been concluded to be due either to a "sealing" of the pores of the activated carbon, or a "filling" of these pores. The removal of aqueous chlorine in Part II was concluded to be reaction rate controlled rather than diffusion rate controlled.

The trends and mechanisms enumerated by this study were based primarily on observations for aqueous chlorine concentrations far in excess of those used in water treatment. However, the data collected at concentrations usually encountered in water treatment practices illustrate that the trends and mechanisms are present at both high and low concentrations. With further study, these trends should allow the formulation of reliable predictive removal equations for aqueous chlorine using activated carbon.

Olson, R.A.

Influence of Fertilizer Practices on Water and the Quality of the Environment.

University of Nebraska, Lincoln, Water Resources Research Institute, June 1974. 88p. (Available from National Technical Information Service (NTIS) as PB-238 624).

Key Words: nitrates, direct contact, surface water (fresh).

Abstract:

Comparison of deep soil cores taken under various crop management systems with adjacent native pasture indicates that generally fertilizer is contributing only minimal amounts of nitrogen to the groundwater (with non-irrigated agriculture) in Nebraska. Under irrigated conditions, nitrogen is leaching to the water table with the greatest amount occurring on sandy soils with shallow water table. An additional threat to the groundwater exists in southwestern Nebraska where the deep loess soils on the table lands are being put under irrigation and the loess beneath contains several tons of NO_3-N per acre of natural or 'geologic' origin. Average nitrate-nitrogen in the groundwater of Nebraska has increased 25% during the past decade. Rapid increases with present high levels are found in several areas with intensive irrigation of sandy soils. The results indicate a need for improved fertilizer and water efficiency under irrigated conditions and further investigation into the environmental hazards.

Olver, J.W., W.C. Krege, and R. H. King.

Heavy Metal Release by Chlorine Oxidation of Sludges.

JWPCF. 47(10):2490-2497. October 1975.

Key Words: iron, zinc, chromium, lead, nickel, copper, chlorination.

Abstract:

The optimum digestion procedure to determine the heavy metal content of sludges was found to be a HNO_3HCl double digestion for 6 hr.

The release of heavy metals from wastewater treatment sludges (primary plus activated or trickling filter humus and anaerobic) is a function of the final pH of the sludge after chlorine oxidation, the type of sludge oxidized, and the species of metals present in the sludge.

Because of the higher alkalinity, the more likely presence of sulfides, and the different metal species present in anaerobic sludges, they release fewer heavy metals than combined or primary sludges for the same chlorine dosage.

Heavy metal release follows the solubility products of pure metal hydroxides and sulfides. Release is a complex process depending not only on pH of the final sludge but also on the metal content and species of the metal found in the sludge. Hence, release will vary considerably from sludge to sludge.

Laboratory chlorination experiments yield data that approach metal release values found in full-scale operation at one particular plant.

The effect of the filtrate from the chlorine oxidation process on a wastewater treatment plant my be considerable if the filtrate is returned to the influent of the plant. Not only are heavy metals recirculated, but the COD, pH, chlorides, TS, total phosphorus, and chloramines found in this filtrate must be considered and evaluated. If pH adjustment is practiced after chlorine oxidation and before the final dewatering method, the filtrate returned to the influent in the wastewater plant would be expected to be less detrimental.

Ongerth, H.J., D.P. Spaeth, J. Crook, and A.E. Greenberg.

Public Health Aspects of Organics in Water.

JAWWA. 65(7):495-498. July 1973.

Key Words: surface water (fresh), surface water (marine).

Abstract:

This is a general discussion of organics in sewerage and water supply.

Orenstein, A.J.

A Note on Consumption of Vegetables Grown on Sewage Irrigated Lands.

Sewage Works Journal. 20:954-955. 1948.

Key Words: crops, groundwater.

Abstract:

This is a report of vegetable consumption and illnesses attributed to sewage irrigated land.

Organic Contaminants in Water Supplies (Committee Report).

JAWWA. 67(8):418-425. August 1975.

Key Words: synthetic/organics, drinking and recreational water.

Abstract:

Water supplies in use for the production of potable water are becoming increasingly susceptible to organic contamination from numerous sources, including agricultural, industrial, municipal, and natural pollution. Historical data obtained from STORET tend to indicate' that the extensive pollution abatement effort that has been undertaken over the past fifteen years has not resulted in a decrease in the concentration of organic contaminants in the waters of the nation. Quite often only trace quantities of organic compounds are required to affect potable water quality seriously.

Community water-supply officials are facing increasing awareness of water quality on the part of the consumer and of the regulatory agencies. This requires that water utilities have in use the best available monitoring and analytical techniques for organic contaminants. The methodology of trace-organic characterization is currently undergoing intensive worldwide study, and rapid development is anticipated in this area.

Orlob, G.T.

Evaluating Bacterial Contamination in Sea Water Samples.

Public Health Reports. 71(2):1246-1252. December 1956.

Key Words: bacteria, surface water (marine).

Abstract:
Direct field inoculation of sea water samples, followed by incubation 5 to 6 hours later, is a satisfactory technique for routine bacterial analysis.

Orlob, G.T.

Viability of Sewage Bacteria in Sea Water.

Sewage and Industrial Wastes. 28(9):1147-1167. September 1956.

Key Words: coliforms, bacteria, surface water (marine).

Abstract:

Changes in populations of coliform bacteria in contaminated sea water during the early hours immediately following collection of the sample may have a significant bearing on the interpretation of the results of bacteriological surveys. Refrigeration of samples, although generally recommended when extended storage of samples is necessary, is not always capable of minimizing the bactericidal effect of sea water. Direct inoculation of the sample into cold media at the sampling site, with a 5- to 6-hour delay in incubation, produces results which are generally comparable with direct inoculation into tempered media followed by immediate incubation. This method is used by the State of Washington Pollution Control Commission and is recommended for general use on bacteriological surveys of sea water.

Osgood, J.O.

Hydrocarbon Dispersion in Ground Water: Significance and Characteristics.

Ground Water. 12(6):427-438. November-December 1974.

Key Words: synthetic/organics, direct contact, groundwater.

Abstract:

Groundwater contamination resulting from hydrocarbon spills is a significant problem which has received little attention. Over two hundred spills to the ground have been investigated during the last two and a half years by the Ground Water Section of the Pennsylvania Department of Environmental Resources. Explosions, injuries, damaged water supplies and other serious consequences have forced the recognition that these cases are important. Since Federal regulations are unsatisfactory in preventing spills to the ground, it is clearly the responsibility of the State to develop meaningful controls.

Hydrocarbon dispersion is essentially a shallow groundwater problem. The hydrogeologic characteristics at the spill site are critical in determining dispersion once the hydrocarbon has reached the water table. The hydrocarbon is largely contained on top of the water table. In unconsolidated deposits or in fill material, the shallow groundwater flow system and the direction of hydrocarbon dispersion will coincide. In sedimentary rocks the orientation of the rock becomes critical. When the dip is shallow enough to contain the water table, dispersion may either coincide with the major flow direction or may diverge from it where facies changes or significant changes in packing are encountered. Dispersion will parallel the strike of the rock in more steeply dipping rocks rather than the major groundwater flow direction. Lateral movement will be controlled by jointing and fracturing. Solution channels and fractures exert the major controlling influence on heavily cemented soluble limestones. In tightly cemented clastics, crystalline rocks and less soluble carbonates, contaminant flows on top of the water table in fractures. Hydrocarbons may be imprisoned where solution channels and fractures do not intercept other openings within the water table plane.

Recovery programs for most hydrocarbon spills are complex. Larger cases receive the greatest attention; however, smaller ones are actually more significant since they are more common. Recovery costs are expen-

sive and complete removal is extremely time-consuming. Better maintenance and emergency response plans must be developed, even by small users. Federal and State governments must recognize the problem as being serious and must develop revolving product recovery funds to be used in groundwater cases. Lastly, groundwater spills must be handled by groundwater specialists. Experimentation by those who lack the proper qualifications can prove very costly.

O'Shaughnessy, J.C., J.B. Nesbitt, D.A. Long, and R.R. Kountz.

Digestion and Dewatering of Phosphorous-Enriched Sludges.

JWPCF. 46(8):1914-1926. August 1974.

Key Words: phosphates, anaerobic digestion.

Abstract:

The data indicate that a biological sludge containing a complex aluminum phosphate precipitate can be processes in an anaerobic digester without harm to the digestion process and without the process causing any phosphorous to be returned to the liquid waste stream.

The measurement of several digestion parameters (alkalinity, volatile acids, pH, gas production, volatile solids destruction) showed that a relatively stable digestion period existed from the beginning of the study until a digester upset occurred. This digester upset was probably related to a drop in the pH of the raw sludges beginning about the twelfth week of the study. The reason for this pH reduction on both raw sludges could not be established, but was corrected by reducing the VSL and adding lime to the primary digester.

Quantitative analyses of digester gas and sulfate ion concentrations in the various sludges showed that sulfate ion added during the removal of phosphorus did not cause hydrogen sulfide to be produced during anaerobic digestion. A high soluble aluminum ion concentration did not occur in the sludges even during the digester upset period.

It appears that removal of phosphorus from wastewater by means of chemical precipitation with either alum or sodium aluminate and the addition of these phosphorus-rich sludges to an anaerobic digester will not have adverse effects on the anaerobic digestion process.

Finally, a series of dewatering tests run on waste activated sludge and combinations of waste activated and University raw primary sludge showed that a sludge that incorporates the precipitates of the chemical additives dewaters more readily than a sludge that does not include these precipitates.

During Phase I, phosphorus was removed from only half of the total plant flow. The amount of precipitated phosphorus that entered the digester during this period was only approximately half the amount that can be expected in a plant treating all of its wastewater for phosphorus removal. During Phase II, phosphorus was removed from only one-fourth of the wastewater flow, and the resulting sludge had phosphorus concentrations which were only one-fourth of those that could be expected in a plant removing phosphorus from all of its flow. Zenz and Pivnicka showed that in a plant treating all of the wastewater flow for phosphorus removal, the average difference in total phosphorus concentrations between the sludge containing phosphorus and the control sludge was 593 mg P/l. In this study, the difference between the phosphorus level in the digested sludge before chemical additions and those after phosphorus removal began was calculated to be 353 mg P/l. However, although a higher phosphorous level would be expected in a waste treatment plant removing phosphorus from its total flow, the effects of the phosphate precipitate should be no different from those recorded in this study.

O'Shaughnessy, J.C., J.B. Nesbitt, D.A. Long, and R.R. Kountz.

Soluble Phosphorus Removal in the Activated Sludge Process. Part II: Sludge Digestion Study.

Pennsylvania State University, University Park, Department of Civil Engineering, October 1971. 59p.

Key Words: phosphates, aluminum, chemical treatment, anaerobic digestion.

Abstract:

Sludges containing aluminum phosphorus precipitates from an activated sludge wastewater treatment plant were digested in a high-rate digester. Sodium aluminate and liquid alum were used to precipitate the phosphorus from the wastewater. Analyses on both raw and digested sludges showed that once precipitated from the wastewater and incorporated into a sludge, the phosphorus did not redissolve while undergoing anaerobic digestion. Most of the soluble phosphorus in both the raw and digested sludges was in the ortho-phosphate form, and the addition of the inorganic aluminum phosphorus complexes did not adversely effect the anaerobic digester. High concentrations of soluble aluminum ion did not appear in the anaerobic digester, and the use of alum for phosphorus removal caused no additional hydrogen sulfide production during sludge digestion. Analyses also indicated the addition of aluminum compounds enhanced the dewatering properties of the raw sludges.

Ottoboni, A. and A.E. Greenberg.

Toxicological Aspects of Wastewater Reclamation - A Preliminary Report.

JWPCF. 42(4):493-499. April 1970.

Key Word: epidemiology.

Abstract:

In a preliminary investigation of the possible adverse effects of wastewater fed to rats, it was observed that (a) male rats given wastewater *ad libitum* gained more weight than control rats; (b) female rats given wastewater had significantly smaller adrenal glands than control females; and (c) two male test rats developed massive tumors not previously seen in this rat strain at such a young age. Possible causes for these differences and their significance are discussed. It is suggested that trace organics may be involved. However, until additional studies, some of which are now underway, are completed, definitive evaluation is impossible.

Overman, A.R.

Effluent Irrigation of Pearl Millet.

Journal of the Environmental Engineering Division, ASCE.
100(EE2):193-199. April 1975.

Key Words: iron, zinc, copper, crops.

Abstract:

Pearl millet responded well to irrigation with secondary municipal effluent. During 25 weeks of irrigation, two cuttings of forage were obtained. The sandy soil showed no evidence of surface clogging. While total dry weight increased, dry matter content decreased with application rate, reflecting increased availability of soil moisture. Corresponding to this was an increase in crop concentrations of N, K, Ca, Mg, and Na.

The crop appeared quite suitable for cattle feed. Yields and forage quality were comparable to those obtained in standard fertility studies. Properly designed and managed, effluent irrigation can be utilized for wastewater treatment and crop production. It is imperative that local conditions be taken into account, particularly soil properties, climate, and hydrological factors.

Owens, L.B. and D.W. Nelson.

Relationship of Various Indices of Water Quality to Denitrification in Surface Waters.

Purdue University, Lafayette, Indiana, Water Resources Research Center, 1972. 22p. (Available from National Technical Information Service (NTIS) as PB-237 701).

Key Words: nitrates, phosphates, nitrification/denitrification.

Abstract:

Water samples were collected monthly from three farm ponds and from three locations on the Wabash River near Lafayette, IN to determine the actual and potential rates of denitrification in such water systems. Denitrification may serve as an important mechanism for nitrate removal from surface waters. Water parameters which may affect denitrification were estimated at the time of sampling and then related to the denitrification rates observed. Actual and potential denitrification rates were normally small unless an energy source was added, indicating that the low amount of dissolved carbon as well as a high dissolved O_2 content may be the factors limiting denitrification in surface waters. Water temperature, pH level, nitrate level, and numbers of denitrifying bacteria appeared suitable for denitrification during most of the year. Higher levels of denitrifying bacteria, nitrate, and phosphorus existed in the river than in the ponds.

Page, A.L.

Fate and Effects of Trace Elements in Sewage Sludge When Applied to Agricultural Lands -- A Literature Review Study.

University of California at Riverside, Department of Soil Science and Agricultural Engineering, January 1975. 107p. (Available from National Technical Information Service (NTIS) as PB-231 171).

Key Words: arsenic, boron, barium, cadmium, cobalt, chromium, copper, mercury, manganese, molybdenum, nickel, lead, selenium, zinc, crops, agricultural sludge disposal.

Abstract:

Concentrations of trace elements in sewage sludges are related to industrial and consumer uses; total concentrations of trace elements in sewage sludges vary widely. Uses of As, Ba, B, Cd, Cr, Co, Cu, Pb, Mn, Hg, Mo, Ni, Se, Ag, Sn, V, and Zn are briefly reviewed.

Page, A.L. and P.F. Pratt.

Effects of Sewage Sludge or Effluent Application to Soil on the Movement of Nitrogen, Phosphorus,Soluble Salts and Trace Elements to Groundwaters.

Presented at the Second National Conference on Municipal Sludge Management and Disposal, Anaheim, California, 1975. 30p.

Key Words: nitrites, total dissolved solids, chlorides, phosphates, cadmium, copper, mercury, lead, nickel, zinc, chromium, cobalt, arsenic, boron, iron, aluminum, direct contact, groundwater.

Abstract:

An overview of the movement of N, P, soluble salts, and trace elements in soils receiving sewage treatment plant effluents and sludges is presented. Factors which influence concentrations which leach to lower depths in soil profiles are discussed. High rate-volume systems designed for disposal or groundwater recharge operations are contrasted to low rate-volume systems designed for agriculture use.

Page, A.L. and A.C. Chang.

Trace Element and Plant Nutrient Constraints of Recycling Sewage Sludges on Agricultural Land.

In: Proceedings of the Second National Conference on Complete WateReuse, Chicago, 1975. pp. 201-209.

Key Words: nitrates, phosphates, arsenic, barium, chromium, cobalt, manganese, nickel, molybdenum, mercury, selenium, agriculture, groundwater, crops, geographic location, economic base.

Abstract:

A summary of minimum, maximum, and median concentrations of trace elements of sewage sludges from more than 120 treatment plants in various communities throughout the U.S. is given. The question of how to determine the amount of sludge a soil may receive over a period of time without creating any harmful effect is discussed. The movement of trace elements in soils is also discussed.

Pagenkopf, G.K. and D.R. Neuman.

Lead Concentrations in Native Trout.

Bulletin of Environmental Contamination and Toxicology.
12:70-75. January 1974.

Key Words: lead, fish.

Abstract:

This paper discusses the uptake of lead by freshwater trout.

Pagenkopf, G.K., R.C. Russo, and R.V. Thurston.

Effect of Complexation on Toxicity of Copper to Fishes.

Journal of the Fisheries Research Board of Canada.
31:462-465. April 1974.

Key Words: copper, surface water (fresh).

Abstract:

Copper (Cu) is highly complexed by carbonate and hydroxide ions in natural waters, and this complexation determines the concentration of copper species in solution. Results of detailed equilibrium calculations on data from bioassays where alkalinity, pH, hardness, and total copper concentration are different indicate that copper (II) is the chemical species that is toxic to fishes and that alkalinity is the factor controlling copper (II) concentration.

Pakkala, I.S., M.N. White, G.E. Burdick, E.J. Harris, and D.J. Lisk.

A Survey of the Lead Content of Fish from 49 New York State Waters.

Pesticides Monitoring Journal. 5(4):348-355. March 1972.

Key Words: fish, lead.

Abstract:

An analytical survey was made of the total lead content of 419 fish of various species sampled in 1969 from 49 New York State waters and a group of lake trout sampled in 1970 from Cayuga Lake only. Most often, lead concentrations ranged from 0.3 to 1.5 ppm, but a few samples contained levels up to 3 ppm. Fish from certain waters including Lakes Canadice, Canadaigua, Erie, Hemlock, Pleasant, and Raquette and the Hudson River showed higher lead levels more consistently than fish from other waters. No correlation was noted between lead concentration and the size, species, or sex of fish, and lead did not appear to be cumulative in the lake trout of known age up to 12 years from Cayuga Lake.

Palin, A.T.

Chemistry of Modern Chlorination.

Water Services. 78:7-12, 53-56. January, February 1974.

Key Words: BOD, cyanides, iron, mercury, chlorination.

Abstract:
This article contains an excellent write-up on the chemistry of chlorine and chlorination.

Papadalsis, J.A.

Bacteriological Examination of Seawater: Observations on Factors Affecting the Performance Media.

Journal of Applied Bacteriology. 39:295-300. 1975.

Key Words: coliforms, bacteria, surface water (marine).

Abstract:

The performance of MacConkey broth and minerals modified glutamate lactose medium was examined in a series of experiments. It was found that the addition of seawater with or without antibacterial activity and the addition of 3·2% NaCl solution to double strength media all had similar harmful effects on their performance. Also a concentration of 3·2% NaCl in ordinary lactose broth caused a great decrease ($P=0.02$) in the number of tubes containing coliform organisms. It is concluded that the high salt content of seawater interferes with lactose fermentation by coliforms. This interference was found to be so great that the number of tubes in which coliform organisms and *Escherichia coli* were detected, dropped from 2.5 to 3.5 times when an equal volume of seawater was added to double strength MacConkey and glutamate media. The results of the last experiment suggest that for best performance of the media, the volume ratio of seawater to medium should be equal or less than 1/10. Also glutamate medium was superior to MacConkey broth ($P < 0.001$), especially in the detection of *E. coli*.

Parhad, N.M. and N.U. Rao.

Effect of pH on Survival of Escherichia coli.

JWPCF. 46(5):980-986. May 1974.

Key Words: Escherichia coli, ponding/land application.

Abstract:

The following results were obtained:

1. The growth of different algae in sterilized wastewater results in an increase of pH from 7.5 to more than 10.

2. E. coli could not grow in wastewater when the pH was greater than 9.2.

3. Both E. coli and algae can grow together when wastewater is buffered at pH 7.5.

4. E. coli, when grown in association with algae, is eliminated because of the high pH produced as a result of algal growth.

5. The decrease in E. coli observed in stabilization ponds need not be attributed to the presence of anti-bacterial substances, to the production of the toxic extracellular products of algae, or to microbial antagonism. It may be attributed to the high pH levels that are found in stabilization ponds.

Paris, D.F., D.L. Lewis, J.T. Barnett, Jr., and G.L. Baugham.

Microbial Degradation and Accumulation of Pesticides in Aquatic Systems.

Environmental Protection Agency, Southeast Environmental Research Laboratory, Athens, Georgia, January 1975. 54p.

Key Words: pesticides, surface water (fresh), surface water (marine).

Abstract:

1. Under conditions found in most aquatic environments (pH 5.6-8.0) chemical hydrolysis of captan occurs too rapidly for microbial degradation or accumulation of the parent compound to be significant.

2. The butoxyethylester of 2,4-dichlorophenoxyacetic acid is rapidly degraded to 2,4-D and butoxyethanol by all bacteria and fungi tested in the laboratory. Degradation of the resulting 2,4-D is a much slower process.

3. Under the conditions of our experiments methoxychlor is not degraded rapidly by bacteria.

4. The major metabolite of malathion degradation by the bacteria and fungi studied is the β-malathion monoacid.

5. In aqueous solution (pH 6.8-7.0, 27°C) containing low concentrations of malathion and low concentrations of malathion degrading bacteria, bacterial degradation can compete with chemical degradation.

6. The growth of the bacteria used to study carbaryl degradation is dependent on the rate of chemical hydrolysis of carbaryl to α-naphthol. In cultures containing α-naphthol the bacteria used in the carbaryl studies utilized α-naphthol as a sole carbon source.

7. The more water soluble pesticides -- atrazine, carbaryl, diazinon, malathion, and parathion -- were not sorbed by any of the bacteria or fungi tested; therefore, microbial sorption of these compounds would not be expected under natural conditions.

8. Sorption of methoxychlor and toxaphene by bacteria, fungi, and algae can be described by a partition coefficient and the process is rapidly reversible.

Parizek, R.R., L.T. Kardos, W.E. Sopper, E.A. Myers, D.E. Davis, M.A. Farrell, and J.B. Nesbitt.

Waste Water Renovation and Conservation.

Pennsylvania State University Studies No. 23.
University Park, 1967. pp. 36-64.

Key Words: nitrates, chlorides, ponding/land application.

Abstract:

The application of treated effluent to croplands and forested areas was initiated in 1962 to develop a means of spraying effluent on land throughout the year, to determine the degree of renovation of effluent, to explore the possibility of conservation of water and to measure the effect on soils, crops, trees and wildlife. The results of the first two years of operation of the effluent irrigation program provide information about a number of aspects.

Park, J.W.

An Evaluation of Three Combined Sewer Overflow Treatment Alternatives.

Clark Dietz and Associates, Urbana, Illinois , December 1974. 123p. (Available from National Technical Information Service (NTIS) as PB-239 115).

Key Words: BOD, suspended solids, combined municipal and/or storm system.

Abstract:

Three different systems (a single-cell overflow retention lagoon, a single-cell facultative lagoon with controlled discharge and a combined holding and sedimentation tank with comminutor, sludge scraper, and influent chlorination) were found to be effective in reducing the measured pollutional discharges during wet weather periods in Shelbyville, Illinois. Partial separation of combined sewers was also effective in maintaining organic loading to the sewage treatment plant during periods of combined sewer overflow.

Parker, C.D.

Microbiological Aspects of Lagoon Treatment.

JWPCF. 34(2):149-161. February 1962.

Key Words: coliforms, fecal streptococci, *Escherichia coli*, ammonia, nitrates, nitrites, BOD, aerated lagoons, anaerobic lagoons, influent characteristics, effluent characteristics.

Abstract:

It is unwise to make broad generalization from the data presented, but it would appear that with aerobic ponds in series following anaerobic ponds something of the order of 30 to 40 days' detention is required to reduce the coliform counts to values comparable with drinking water standards and about half that time with lagoons following trickling filters. It would appear to be difficult to obtain very low coliform counts using single-cell aerobic ponds.

These studies have demonstrated that widely different levels and types of algal population develop in ponds designed and operated in different ways. While high levels are uniformly present in unicell aerobic ponds, algal levels in multicell ponds are much more variable and at a lower level. By the use of multicell ponds it is possible to obtain relatively clear effluents free from objectionable algal turbidity. Such low level algal count effluents can also be obtained in lagoons after high-rate filters.

The reason for the difference in algal development is difficult to find with present knowledge of algal physiology. It is true that in multicell ponds the level of BOD throughout any one pond is far more uniform than it is in the unicell installations. However, even in the ponds of the multicell installations where the BOD is similar to the average value in the larger unicell pond, algal populations are much lower. Certainly lack of short-circuiting in the multicell ponds would promote the segregation of successive biological developments with progressive time in each pond but it appears that such a horizontal stratification of processes does induce different algal conditions.

The lower algal population in these multicell aerobic ponds raises the question as to the function of algae in lagoon treatment and the effect of such lower algal content on efficiency of BOD removal. Experiments are at present

being planned to determine this point.

It must be concluded that the algal population of the final effluent can be influenced by lagoon layout and operation and that low algal content effluents can be obtained by appropriate means.

Parker, D.G., C.W. Randall, and P.H. King.

Biological Conditioning for Improved Sludge Filterability.

JWPCF. 44(11):2066-2077. November 1972.

Key Words: coxsackie virus, drying beds, anaerobic digestion.

Abstract:

This article is a general discussion on sludge processing, with no reference to health contaminants.

Parker, D.S., D.G. Niles, and F.J. Zadick.

Processing of Combined Physical-Chemical-Biological Sludge.

JWPCF. 46(10):2281-2300. October 1974.

Key Words: suspended solids, centrifugal thickeners, anaerobic digestion, incineration, gravity thickeners.

Abstract:

The following conclusions may be drawn from this study:

1. Combined sludge generated in a chemical primary sedimentation tank in which lime is the coagulant may be accurately estimated from changes in quality constituents across the process and knowledge of chemical dosages.

2. Considerable sludge thickening takes place in the primary sedimentation tank. Only the first half of the rectangular tank, however, is effective for thickening. Thicker sludge is obtained at pH 11.0 and 11.5 than at pH 10.2.

3. Combined sludge may be effectively classified with a solid bowl centrifuge. For flocculation pH's of 11.0 and 11.5, approximately 90 percent of the calcium carbonate fed to the machine was recovered in the cake. At the same time, 50 to 75 percent of the other major constituents, except acid-insoluble inerts, were rejected in the centrate. The calcium carbonate-rich cake was simultaneously dewatered to a TS content of greater than 50 percent. At pH 10.2, the calcium carbonate recovery was 75 percent, while the rejection of the other materials was 60 percent. Cake dryness at pH 10.2 was 42 to 49 percent TS.

4. Centrate from the first-stage classification centrifuge may be dewatered in a second-stage solid bowl centrifuge. Anionic polymer addition is required at a dosage of at least 2 lb/ton (1 kg/metric ton) dry solids. The pH of flocculation affects the cake dryness obtained. Below pH 11.0, TS in the cake of 17 to 18 percent was obtained. Above pH 11.0, dewatering deteriorated and a median cake TS of 12 percent was produced.

5. Anaerobic digestion can stabilize first-stage centrate, but volatile matter reduction is less for centrate processing for conventional raw sludge processing. Furthermore, virtually all of the magnesium hydroxide fed to the digester is solubilized because of the pH of digester

operation (pH 7.0 to 8.0) and is returned to the process in the form of soluble magnesium and bicarbonate alkalinity. Calcium carbonate and calcium phosphate are not dissolved in the digestion process to a significant degree.

6. Three feasible solids disposal alternatives have been developed for lime sludge processing. One involves incineration of the waste solids with separate recalcination of the calcium carbonate. The second involves incineration of the whole sludge with integral recalcination and subsequent ash beneficiation before lime reuse. The third solids disposal alternative involves disposal of the calcium carbonate in landfill with digestion of the organic solids. The two incineration-recalcination alternatives are preferred, because chemical costs are significantly less and far fewer solids are produced for ultimate disposal. Of the two recalcination alternatives, the ATTF solids processing system involves less cycling of solids while maximizing lime recovery; it therefore is the preferred alternative.

Parker, D.S., F.J. Zadick, and K.E. Train.

Sludge Processing for Combined Physical-Chemical Biological Sludges.

Central Contra Costa Sanitary District, Walnut Creek, California, July 1973. 146p. (Available from National Technical Information Service (NTIS) as PB-223 241).

Key Words: suspended solids, centrifugal thickeners, anaerobic digestion.

Abstract:

One of the most pressing needs of designers of advanced waste treatment systems is for meaningful design information on solids disposal systems. This report concludes that (1) combined sludge generated in a chemical primary sedimentation tank where lime is the coagulant can be accurately estimated from changes in quality constituents across the process and knowledge of chemical doses; (2) considerable sludge thickening takes place in the primary sedimentation tank; (3) combined sludge can be effectively classified with a solid bowl centrifuge; (5) anaerobic digestion can stabilize first stage centrate, but volatile matter reduction is less for centrate processing than for conventional raw sludge processing; (6) combined sludge can be stabilized by chlorination treatment; (7) two feasible solids disposal alternatives have been developed for combined sludge processing.

Recommendations are made for future investigations.

Parker, M. and A.D. Hasler.

Studies on the Distribution of Cobalt in Lakes.

Limnology and Oceanography. 14:229-241. March 1969.

Key Words: cobalt, surface water (fresh).

Abstract:

Cobalt-57 was added to bottles of lake water to see whether there were any seasonal changes in the apportionment of cobalt between solution (filtrate) and seston after 24-hr incubation or whether any differences in this distribution could be found between lakes.

Several distinct patterns in the seasonal apportionment of ^{57}Co between "solution" and seston were observed, but no explanation of the basic mechanism causing these changes is offered. In two of the lakes there was a statistically significant relation between certain detrital particles, rhizopods, and the percent of introduced ^{57}Co associated with solids.

In general, direct biological uptake did not appear to be significant in removing ^{57}Co from solution in Lake Mendota's epilimnion. Photosynthetic activity was of little influence. Experiments with inhibitors and heated water also indicated that nonbiological processes were most important. Autoradiographs showed little radioactivity associated with algae.

Parkhurst, J.D.

Virus Study: Supplement to the Project Report for Facilities Planning Study.

Los Angeles County Sanitation District. November 1974.

Key Words: viruses, chemical treatment.

Abstract:

This is a proposal of virus work to be done. No data is available at this time.

Parkhurst, J.D., R.P. Miele, S.T. Hayashi, and R.P. Rodrigue.

Dewatering Digested Primary Sludge.

JWPCF. 46(3):468-485. March 1974.

Key Words: suspended solids, centrifugal thickeners, drying beds.

Abstract:

A sludge dewatering research program was conducted to find a system capable of recovering 95 percent of the solids from an anaerobically digested sludge. Fourteen months of pilot plant studies revealed five conditioning-dewatering schemes that satisfied the requirement. Based on economic and other factors, a two stage centrifugation system using horizontal scroll centrifuges followed by basket centrifuges was selected. Sludge conditioning is accomplished by polymer addition to the basket centrifuge feed. Sludge cake from the centrifuges will be hauled to a landfill for ultimate disposal. The unit cost for dewatering and disposal of 300 dry tons/day (272,100 kg/day) was estimated to be $29/ton ($0.032/kg). Present plans call for a fully operational two stage centrifuge sludge dewatering system at the JWPCP by October 1975.

Patil, K.C., F. Matsumura, and G.M. Boush.

Metabolic Transformation of DDT, Dieldrin, Aldrin, and Endrin by Marine Microorganisms.

Environmental Science and Technology. 6(7):629-632. July 1972.

Key Words: DDT, surface water (marine).

Abstract:

The most significant observation in the entire study appears to be that these insecticides are not metabolized in plain seawater. The insecticides were not degraded even in relatively polluted estuarine waters such as the ones from Kaneohe Bay and Pearl Harbor, Hawaii. The only water sample which showed any degree of degradation was the one from fish ponds which contained algal populations.

On the other hand, most of the strong degradation activity was found to be associated with biological samples such as algae, plankton, surface films, and microorganisms. The patterns of degradation of insecticides, in general, closely resemble those found in the terrestrial and aquatic (freshwater) flora and fauna (Matsumura and Boush, 1971), except that algal cultures appear to convert DDT exclusively to a DDOH-like compound.

Apart from the pure cultures of microorganisms and algae, there is a question of the closeness of the laboratory incubation conditions to the actual field situations. This is particularly true for the surface films which contain delicate microscopic organisms. These organisms are expected to die within 24 hr after collection. This is the reason why the insecticides were given at the site within 1 hr after collection. Nevertheless, change in microflora and fauna during the incubation process is inevitable in all field samples.

In the absence of truly adequate methods to simulate field conditions, the approach of comparing the degradation patterns in field-incubated samples vs. those in pure cultures of organisms isolated from the corresponding field samples at least should provide a general information.

Patterson, C.C.

Contaminated and Natural Lead Environments of Man.

Archives of Environmental Health. 11(3):344-360. September 1965.

Key Words: lead, direct contact, surface water (fresh), surface water (marine), livestock, groundwater.

Abstract:

This is an excellent general review of lead and lead pathways by a foremost expert on trace lead analysis.

Patterson, J.W.

Mercury in Laundry Wastewaters.

Illinois Institute for Environmental Quality, Chicago, Illinois, March 1975. 45p.

Key Words: mercury, combined municipal and/or storm system.

Abstract:

The consistent occurrence of mercury in commercial laundry wastewaters is attributable to two categories of source. A major source, perhaps representing half or more of the mercury discharged, is mercury removed from soiled fabrics in the laundering process. The limited data indicate consistent mercury levels except for the one linen laundering wastewater. This higher mercury level may reflect hospital linen contamination with mercurial-containing pharmaceutical ointments.

The second major source of mercury results from use of mercury-contaminated laundering chemicals. Chemicals for which significant mercury content is indicated include caustic (70-250,000 μg/l Hg), hydrofluosilicic acid (2,400 μg/l Hg), bacteriostats and mildicides such as phenyl mercuric acetate, and various soaps and fabric softeners which frequently contain bacteriostatic agents.

There are many types of treatment technology available for mercury control. Among the processes shown, iron and calcium chloride coagulation, and activated carbon adsorption have the capability to meet the Illinois effluent standard of 0.5 μg/l. However, for the mercury levels found in commercial laundry wastewaters, only activated carbon would consistently achieve an effluent value below the Illinois standard. The activated carbon process has been proven successful, achieving below 0.25μ g/l Hg on a commercial laundry waste.

In addition to wastewater treatment, there are two other mercury abatement processes available to commercial laundries. One of these is to substitute mercury-free laundering chemicals for those containing mercury. The second is to pretreat laundering chemicals before their use, to remove mercury. As an example, caustic soda mercury may be reduced to below 500 μg/l by filtering prior to use. For an average concentration of 3,267 μ g/l, filtration prior to caustic use would reduce mercury in the caustic by about 85 percent, and possibly in the wastewater by as much as 40 percent.

Patterson, J.W.

Wastewater Treatment Technology.

Ann Arbor Science Publishers, Ann Arbor, Michigan. 1975. 265 p.

Key Words: arsenic, barium, boron, cadmium, chlorides, chromium, copper, cyanides, fluorides, iron, lead, manganese, mercury, nickel, oil and grease, synthetic/organics, selenium, zinc, total dissolved solids, activated sludge, filtration.

Abstract:

This article describes treatment technologies for removal of certain elements and other parameters.

Patterson, J.W., P. Shimada, and C.N. Haas.

Heavy Metals Transport Through Municipal Sewage Treatment Plants.

In: Proceedings of the Second National Conference on Complete WateReuse, Chicago, 1975. pp. 210-213.

Key Words: cadmium, copper, nickel, lead, zinc, gravity separators, activated sludge, filtration, anaerobic digestion.

Abstract:

This article describes original research on a model waste disposal plant determining heavy metal, soluble transportation in influent and effluent waters after: 1) primary (gravity settlement), 2) secondary (activated sludge), 3) tertiary (sand filtration), and 4) anaerobic digestion.

Pavia, E.H. and C.J. Powell.

Stormwater Disinfection at New Orleans.

JWPCF. 41(4):591-606. April 1969.

Key Words: coliforms, BOD, suspended solids, surface water (fresh).

Abstract:

New Orleans, as many other cities, has the problem of polluted runoff, even though it maintains two entirely separate sewer systems -- a sanitary system, and a storm system. Unstable soil conditions and a high water table coupled with leaky joints on the older portions of the system all contribute to the problem of interchange between the sanitary and storm systems. This interchange coupled with the normally polluted runoff results in a storm water pumpage extremely high in coliform count. Counts in the magnitude of 100,000,000 coliform/100 ml are not unusual.

The Pre-Construction Evaluation Program started in February 1976 has confirmed the belief that the stormwater is basically of good quality and does not cause deleterious effects on the quality of water in Lake Pontchartrain with the exception of coliform level. A plot of the parameters measured during this "pre-construction" program shows that the BOD ranged from practically 0 to a maximum of 50 mg/l, the suspended solids from 5 to 100 mg/l, the dissolved oxygen from 0 to 13 mg/l. During this period, however, the coliform count was above the acceptable limits.

Pavlou, S.P., R.N. Dexter, and J.R. Clayton, Jr.

Chlorinated Hydrocarbons in Coastal Marine Ecosystems.

Presented at the International Conference on Transport of Persistent Chemicals in Aquatic Ecosystems, Ottawa, 1974.

Key Words: chlorinated hydrocarbons, surface water (marine), fish, air.

Abstract:

Observed distributions of chlorinated hydrocarbons in California coastal zones are discussed in terms of the input mechanism, the circulation characteristics, and the primary productivity of the area under investigation. Considerations of transport within the ecosystem include spatial distribution and phase fractionation from ambient water.

Pavlou, S., K. A. Krogslund, R. N. Dexter, and J. R. Clayton.

SYOPS (Synthetic Organics in Puget Sound) Cruise Series 1, 2, 3, 4. Hydrographic, Chemical and Biological Measurements. R/V Onar Cruises 435, 450, 469, 502.

University of Washington, Seattle, Department of Oceanography, 1973. 178 p. (Available from National Technical Information Service (NTIS) as PB-227 060)

Key Words: chlorinated hydrocarbons, copper, zinc, lead, surface water (marine).

Abstract:

Raw data are reported on the concentrations of chlorinated hydrocarbons in zooplankton and sediments of Puget Sound, and Cu, Pb, and Zn concentrations in water are given.

Pavlou, S.P., T. E. Whittedge, J. C. Kelley, and J. J. Walsh.

A Systems Approach to Marine Pollution Monitoring.
Personal Communication.

Key Words: surface water (marine).

Abstract:

This article gives a description of the objectives, field program, and systems analysis approach which will be used in a planned study of the physical, chemical, and biological dynamics of a marine ecosystem. It has limited application to health effects.

Pavoni, J.L. and D.J. Hagerty.

Adsorption of Pesticides by Clay Minerals.

Journal of the Sanitary Engineering Division, ASCE.
97(SA 2):243-244. April 1971.

Key Words: chlorinated hydrocarbons, surface water (marine), surface water (fresh).

Abstract:

This article is a discussion of the effect of pH on clay surface adsorption. Two types of adsorption onto clay surfaces are possible: physical and chemical. In the case of surfactant-oxide systems where the surfactant is adsorbed only by physical forces, pH exerts a significant influence because of its control of surface charge.

Pavoni, J.L. and M.E. Tittlebaum.

Virus Inactivation in Secondary Wastewater Treatment Plant Effluent Using Ozone.

In: Virus Survival In Water and Wastewater Systems. J.F. Malina, Jr. and B.P. Sagik, eds. University of Texas at Austin, Center for Research in Water Resources, 1974. pp. 180-198.

Key Words: viruses, ozonation.

Abstract:

The conclusions derived from this research investigation may be summarized as follows:

1. F_2 virus was shown to be sustained in secondary effluent wastewater for at least 5 hours. This phenomenon illustrates that disinfection procedures must be practiced to insure viral removal in wastewater.

2. F_2 virus concentrations were shown to be unaffected by the flow or mixing of the ozone reactor.

3. F_2 virus was inactivated with virtually 100 percent efficiency after a contact time of 5 minutes at a total ozone dosage of approximately 15 ppm and a residual of 0.015 ppm.

4. E. coli bacteria and f_2 virus were inactivated with virtually 100 percent efficiency after a contact time of less than 15 seconds in the absence of ozone demanding material.

5. An extremely small number of viral particles was observed in effluent studies. These bacteriophages seem to be either resistant or not completely removed by ozonation at the dosage level or contact period utilized during this investigation.

Pavoni, J. L., M. E. Tittlebaum, H. T. Spencer, M. Fleischman, C. Nebel, and R. Gottschling.

Virus Removal from Wastewater Using Ozone.

Water and Sewage Works. 119(12):59-67. December 1972.

Key Words: viruses, ozonation.

Abstract:

The conclusions derived from this investigation may be summarized as follows:

1. F_2 virus was shown to be sustained in secondary effluent wastewater for at least 5 hours.

2. F_2 virus concentrations were shown to be unaffected by flow or mixing in the ozone reactor.

3. F_2 virus was inactivated with virtually 100 percent efficiency after a contact time of 5 minutes at a total ozone dosage of approximately 15 ppm and a residual of 0.015 ppm.

4. A small amount of virus was observed in effluent studies. These were either resistant or not completely removed by ozonation at the dosage level or contact period used.

5. Within the scope of this investigation, the rate of inactivation was greater for F_2 bacteriophages than either bacteria or carbonaceous material.

6. It appears that the mechanism of kill of bacterial cells and viral particles was probably that of oxidation. It was theorized that ozone acts as a general cytoplasmic oxidant which causes cenlysis and the release of soluble COD.

7. F_2 bacteriophage is used as a test-phage with some difficulties. Although it is easy to culture and assay, difficulties were encountered when very low viral concentrations were plated. There was often growth of non-specific bacteria on the specific bacterial lawn which made accurate plaque counting difficult.

8. Standards of ozone use in wastewater are needed. Current standards are concerned only with chlorine as a disinfecting agent. The contact times and dosage levels for chlorine are not applicable to ozone. The *E. coli* indicator, presently the only indicator of disinfection efficiencies, cannot be used to evaluate the presence of viral agents.

Recommendations for future investigations:

1. The discovery of a good indicator bacteriophage whose presence in water or wastewater could be definitely correlated to the presence of animal viruses of importance to man.

2. The development of assay procedures for test bacteriophages which will allow relevant comparisons of different disinfection process data.

3. Further study results to determine the characteristics of bacteriophages resistant to, or not completely removed by ozonation, and to evaluate their importance to man.

4. Studies concerning the possiblity of viral particle regeneration after ozone inactivation.

5. The development of a separate viral index to be used in conjunction with the coliform index, thereby allowing proper evaluation of both bacterial and viral content in treatment plant effluents.

6. Analysis of the actual kill mechanism of bacterial and viral cells by ozone to allow optimization of disinfection procedures.

7. The determination of whether virus, bacteria or carbonaceous material is inactivated or removed most efficiently by ozone.

8. The development of appropriate dosage levels and contact times for ozone treatment of wastewater to insure adequate viral inactivation, bacterial kill and carbonaceous material removal.

Pearson, F. and T.G. Metcalf.

The Use of Magnetic Iron Oxide for Recovery of Virus from Water.

University of New Hampshire, Durham, Water Resources Research Center, 1974. 44 p. (Available from National Technical Information Service (NTIS) as PB-234 626)

Key Words: viruses, chemical treatment.

Abstract:

Demonstration of an enterovirus in surface waters presumes an ability to detect the presence of a few virus particles in large volumes of water. The study describes the development of equipment and methods which sought to combine the virtues of flow-through procedures with the virus-removal capabilities of magnetic iron oxide. Factors influencing virus-iron oxide interaction and the effectiveness of equipment and methods for recovery of virus were examined. Special attention was directed to theoretical aspects of virus-iron oxide interactions, and an explanation of the basis of interaction sought.

Pennypacker, S.P., W.E. Sopper, and L.F. Kardos.

Renovation of Wastewater Effluent by Irrigation of Forest Land.

JWPCF. 39(2):285-296. February 1967.

Key Words: nitrates, phosphates, chlorides, crops.

Abstract:

The reported investigation indicates the following conclusions with regard to the renovation of wastewater effluent through the irrigation of forest land:

1. ABS, the only constituent in the effluent which exceeded the levels acceptable under the U.S. Public Health Service Standards for potable water, was decreased below this level after passing through as little as 6 in (15.2 cm) of mineral soil when up to 2 in (5.1 cm) of effluent were applied per week and through as little as 3 ft (0.9 cm) of mineral soil when the effluent application was at a level of 4 in /wk (10.2 cm/wk).

2. Phosphorus, which is principally responsible for the eutrophication of lakes and streams, was removed to such a degree that water percolating to the groundwater contained an average of less than 0.04 to 0.07 mg/l.

3. The higher level of application, 4 in/wk (10.2 cm/wk), required 2 to 4 times as great a soil depth to remove equal amounts of the nitrate, nitrogen, potassium, calcium, magnesium, and sodium.

Results of this study appear to indicate that application of wastewater effluent to forest land areas may offer a solution to both water pollution and water supply problems which plague many areas. At a disposal level of 2 in/wk (5.1 cm/wk) only 129 acres (52 ha) would be required for the continuous disposal of 1 mgd (3.785 cu m/day) of wastewater, equivalent to the average wastewater treatment plant output of a community of 10,000 persons.

Pereira, M.R. and M.A. Benjaminson.

Broadcast of Microbial Aerosols by Stacks of Sewage Treatment Plants and Effect of Ozonation on Bacteria in Gaseous Effluent.

Public Health Reports. 90(3):208-212. May-June 1975.

Key Words: bacteria, air.

Abstract:

The purpose of the investigation was to demonstrate that microbial pollution of the air by sewage treatment plants is an environmental factor which deserves more intensive study. The data derived from this study should be taken into account in planning and locating sewage treatment plants, since these facilities are often constructed in or near residential areas. The sewage treatment plant under study is one of the few in New York City where odor control is being attempted by mixing ozone with the gaseous effluent. This process is applied only at the building housing the thickening tanks. In the future, this system of odor control is slated for application to all sewage treatment plants in New York City. Sampling the open air in the vicinity of the plant from December 1970 to January 1971 was done equidistantly (about 300 meters from the aeration building) upwind at a neighborhood school and downwind at dockside on Shell Bank Creek. These stations were probably not the best locations from a maximum aerosol coverage standpoint, but they were the most accessible. The air inside the aeration building was sampled during December 1970 and January and March 1971. The internal atmosphere of one exhaust stack was sampled during March 1971. From this study it was concluded that the bubbling of air into aeration tanks causes some of the bacteria concentrated at the liquid-air interface to become airborne. Thus, these bacteria are found in great numbers in the atmosphere of aeration buildings. The air currents created by fans in the wall of the buildings and in the exhaust stacks carry numbers of bacteria into these stacks and from there into the outside air. Among these bacteria are viable potential respiratory pathogens. Ozonation does not appreciably attenuate these aerosols. The results point to the existence of a possible health hazard, such as mycobacterial disease, especially for sewage treatment plant workers and for highly susceptible population groups such as young children, the elderly, and the infirm who reside in areas where the atmosphere is contaminated by the gaseous effluent of sewage treatment plants.

Perhac, R.M.

Distribution of Cd, Co, Cu, Fe, Mn, Ni, Pb and Zn in Dissolved and Particulate Solids from Two Streams in Tennessee.

Journal of Hydrology. 15:177-186. 1972.

Key Words: cadmium, cobalt, copper, iron, manganese, nickel, lead, zinc, surface water (fresh).

Abstract:

In order to study metal distribution in streams, four water samples were taken from two streams in northeast Tennessee. One drains an area of exposed minor zinc mineralization. Three classes of solids were extracted from the water: coarse particulates (> 1500 Å), colloidal particulates (<1500 Å, >100 Å) and dissolved solids. Each particulate fraction was extracted by continuous flow ultracentrifugation. The dissolved solids in the remaining effluent were recovered by evaporation. Of the total solid, the dissolved fraction accounts for over 95%; colloids make up less than 1%. The three solid fractions were totally dissolved and analyzed for Cd, Co, Cu, Fe, Mn, Ni, Pb, and Zn. The dissolved solids always contain the lowest concentrations of metal (ppm metal in solid); the colloids have the highest, typically more than 10 times that of the dissolved material. The coarse particulates occupy an intermediate position. Despite its low concentration, generally over 90% of each metal occurs in the dissolved state. Less than 10% occurs with the coarse particulates, less than 1% as colloids.

Perhac, R.M.

Water Transport of Heavy Metals in Solution and by Different Sizes of Particulate Solids.

University of Tennessee, Knoxville, Water Resources Research Center, March 1974. 45 p. (Available from National Technical Information Service (NTIS) as PB-232 427).

Key Words: cadmium, cobalt, copper, iron, manganese, lead, zinc, surface water (fresh).

Abstract:

The transport of heavy metals by water and bottom sediments was studied in three streams in east Tennessee. One stream is in an industrialized, urban area; a second flows over exposed carbonate rocks which contain zinc minerals; the third is in a rural, nonmineralized area. Dissolved solids, particulates, and bottom sediment were analyzed for a suite of heavy metals, principally, Cd, Co, Cu, Fe, Mn, Ni, Pb, and Zn. Most of the heavy metal is transported in solution. The concentration of metals in the particulates (especially colloids) is very high but the amount of particulate matter is exceedingly low. The amount of heavy metals in the bottom sediment differs considerably from sample to sample.

Perkins, M.A., C. R. Goldman, and R. L. Leonard.

Residual Nutrient Discharge in Streamwaters Influenced by Sewage Effluent Spraying.

Ecology. 56:453-460. Spring 1975.

Key Words: nitrates, surface water (fresh).

Abstract:
The combined results of the chemical analyses and bioassay experiments indicate that the unique nutrient and algal growth characteristics of the lower reaches of Heavenly Valley Creek are related to the history of sewage effluent spraying in Area I. It is demonstrated that exceptionally high concentrations of NO_3^{-1}-N were released into the stream in a 15-mos. period in 1970-71. One researcher has commented on the nutrient regulating effect of forest vegetation by uptake and storage as well as by influencing the flow of water through the soil profile. Others have demonstrated the increased nutrient output due to removal of forest vegetation and the importance of vegetation in maintaining nutrient cycling within the ecosystem. The results presented in this report indicate a similar type of nutrient release which, when coupled with the accumulation of nutrients contained in sewage effluent, can create a long-term potential for eutrophication of the receiving body of water.

Phytoplankton growth in Lake Tahoe has been shown to be most limited by nitrate. Researchers have also shown close correlation between primary productivity and UV absorbance in lake waters off the south shore. They suggested that this UV absorbance may be due to NO_3^{-1}-N, or dissolved organic matter, or both, present in the water. Although the data did not reveal a consistently strong, positive correlation between NO_3^{-1}-N concentration and UV absorbance in the present study, there was no doubt that the high UV readings were traceable to drainage from the effluent sprayed area. It was concluded that the UV absorbance noted and its correlation with primary productivity were in fact indicators of the enrichment of southern Lake Tahoe by drainage from the two sprayed areas within the Trout Creek-Upper Truckee River watersheds.

Because of the sensitivity of the coniferous soil-vegetation system to unseasonal flooding and possibly to toxic substances in the effluent, and because of the sensitivity of the aquatic systems to nutrient additions, large-scale land disposal of secondary sewage effluent is inappropriate in the Tahoe basin.

Perry, R.

Mercury Recovery from Contaminated Waste Water and Sludges.

EPA-660/2-74-086, Georgia-Pacific Corporation, Bellingham, Washington, Bellingham Division, December 1974. 130p. (Available from National Technical Information Service (NTIS) as PB-238 600).

Key Words: mercury, chemical treatment, heat treatment.

Abstract:

Sulfide precipitation offers several advantages over other methods of Hg removal from water; fewer process steps, pH range compatible with total plant effluent, concentrated Hg products, inexpensive chemicals used, and minimal environmental stress.

Perspectives on the Control of Viral Hepatitis, Type B.

Morbidity and Mortality Weekly Report Supplement. U.S. Center for Disease Control, HEW. 25(17). May 7, 1976.

Key Words: hepatitis virus, epidemiology.

Abstract:

This is a joint statement by the Committee on Viral Hepatitis, Division of Medical Sciences, National Academy of Sciences-National Research Council, and the Public Health Service Advisory Committee on immunization practices.

Peterson, F.L. and D.R. Hargis.

Subsurface Disposal of Storm Runoff.

JWPCF. 45(8):1663-1670. August 1973.

Key Words: chlorides, nitrates, COD, coliforms, combined municipal and/or storm system.

Abstract:

Injection of storm runoff into the basal groundwater body from Kahului Development Company facility will occur in zones below the freshwater lens. The quality of the storm runoff generally is good, with low DS and low chloride concentrations. The general effect of injection will be a decrease in DS of the groundwater near the wells. Some fecal coliform will undoubtedly be introduced into the aquifer through the disposal wells; however, dilution of the injected runoff by the groundwater and the hostile environment presented by the saline water in the disposal zone should greatly reduce any contamination hazard represented by the fecal coliform.

Data collected indicate that the SS concentration may be as high as 55,600 lb (25,700 kg) of sediment for the maximum design storm of 2.5 mil cu ft (70.8 mil 1) of runoff. This amount of sediment, if it all entered the well, could significantly reduce the efficiency of the disposal operation.

Pumping and injection tests of the completed injection wells indicate that the disposal wells should be able to inject at rates in excess of 5,500 gpm (20,800 1/m) if significant clogging from sediment does not occur and if hydraulic interference among the four wells operating simultaneously is not significant.

Peterson, J.R., C. Lue-Hing, and D.R. Lenz.

Chemical and Biological Quality of Municipal Sludge.

In: Conference on Recycling Treated Municipal Wastewater through Forest and Cropland. W. E. Sopper and L. Kardos, eds. EPA-660/2-74-003, Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp. 28-39.

Key Words: ammonia, phosphates, zinc, boron, germanium, manganese, aluminum, cadmium, chlorides, chromium, copper, nickel, lead, protozoa, salmonella, Escherichia coli, anaerobic digestion, vacuum filters.

Abstract:

This data gives a comparison of the chemical content of various sludge types.

Petrocelli, S.R., A.R. Hanks, and J. Anderson.

Uptake and Accumulation of an Organochlorine Insecticide (Dieldrin) by an Estuarine Mollusc, Rangia cuneata.

Bulletin of Environmental Contamination and Toxicology. 10:315-320. November 1973.

Key Words: dieldrin, shellfish.

Abstract:

The results of this study indicate that Rangia is capable of taking up and concentrating dieldrin in its tissues to levels far above ambient. The smallest dieldrin residue in the experimental clams was 38.2 μg/kg (water dieldrin level at 0.50 μg/L) after 12 hours of exposure. The largest residue was 1226 μg/kg (water at 0.63 μg/L) after 60 hours of exposure. The means for the 12 and 24 hour groups (67 μg/kg and 118 μg/kg, respectively) showed about a 200 fold increase above ambient, while the 36 hour groups (385 μg/kg) had an increase of almost 800 times. Maximum increase was over 2000 times ambient.

Pettyjohn, W.A., L.R. Hayes, and T.R. Schultz.

Concentration and Distribution of Selected Trace Elements in the Maumee River Basin, Ohio, Indiana and Michigan.

Ohio State University, Columbus, Water Resources Center, March 1974. 206 p. (Available from National Technical Information Service (NTIS) as PB-234 013)

Key Words: aluminum, cadmium, chromium, cobalt, copper, lead, mercury, tin, zinc, surface water (fresh).

Abstract:

During the period 1971-73, water and stream-bottom sediment samples were collected from 225 sites distributed throughout the Maumee River Basin, which lies largely in Ohio. The samples were examined by atomic absorption methods in order to determine concentrations of Ag, Al, Cd, Co, Cr, Cu, Hg, Ni, Pb, Sn, Sr, and Zn. The concentration of these elements in both water and sediment included a wide range, but in most cases the concentrations in water are very small while in sediment they may be very large. Seven municipalities in the basin are characterized by large concentrations of one or more elements in water or sediment, probably resulting from industrial and municipal waste disposal.

Pfeiffer, K.R.

The Homestead Typhoid Outbreak.

JAWWA. 65(12):803-805. December 1973.

Key Words: salmonella, viruses, groundwater, chlorination.

Abstract:

Two samples collected from the trench dug to expose the abandoned sewer were positive for salmonella but not Salmonella typhi. However, the presence of a pathogen in the immediate vicinity of the wells (20 ft from the main supply) is apparently a good indication of severe well contamination. It is also proof, the author believes, that the outbreak originated with the water supply.

Substantiating proof of this hypothesis is based on the presence of an as yet undetermined virus collected from the 6-in well. The virus isolate could not be confirmed. Both the salmonella and the virus are being typed at the present time.

One can only speculate about the cause of the outbreak. However, several sources of well contamination were possible:

1. The drainage ditch continuously showed contamination. It was not connected to any moving body of water and circumscribed the entire camp. The sewage-treatment facility discharged into the ditch, thus creating a possible infection source. Groundwater motion to the southeast or east-southeast was indicated. The ground is probably underlain with considerable solution channels thereby eliminating any rock-filtration effect. Evidence of two small solution channels was shown in the north and west pits.

2. A dry well located in the immediate vicinity of the well field was indirectly connected, possibly by solution channels, to a supply well - an "excellent" means of contaminating the supply well. Furthermore, there was evidence of human fecal contamination in the area around the well and the dry well was constructed in such a way as to provide an outside commode.

3. The abandoned sewer, which ran 15-20 ft from the well, showed what appeared to be a surface-water-intrusion flow, although a dye test on the building located over this sewer line showed no connection. However, the sewer line cannot be eliminated as a possible source due to the fact

that two positive salmonella organisms were isolated from it.

4. Another possible source of contamination was the ground surrounding the well house. Dye studies showed the ease with which contamination on the surface could reach the supply wells, possibly because of the presence of solution channels in the area.

The author believes that the contamination of the water supply occurred at a time when chlorine was not being fed into the system and that the contamination itself was in an instantaneous dose. The author's records show that the chlorine cylinder was expended on or about the date of the probable contamination.

As to the issuing source of the disease, it should be noted that a 7-yr-old girl was hospitalized in Jan. 1973 with typhoid fever. It was shown that this child frequented the residence of a 40-yr-old female neighbor who, although she did not prove to have typhoid, according to serologic tests, probably was a typhoid carrier.

Phillips, W.J. II.

The Direct Reuse of Reclaimed Wastewater: Pros, Cons, and Alternatives.

JAWWA. 66(4):231-237. April 1974.

Key Words: suspended solids, COD, total organic carbon, nitrates, BOD, fecal streptococci, coliforms, phosphates, chlorides, ammonia, nitrites, arsenic, cadmium, chromium, lead, mercury, copper, zinc, influent characteristics, effluent characteristics, activated sludge, chlorination.

Abstract:

One of the best known of the U.S. programs in wastewater reuse is the Santee project in San Diego County, California. Santee utilizes a modified activated-sludge process followed by retention in oxidation ponds and chlorination prior to percolation. The water then follows a limited underground path prior to dilution with natural ground waters and emergence into a set of man-made recreational lakes. Excellent removal of viruses and bacteria has resulted in the use of the lakes for boating and fishing.

Physical-Chemical Nitrogen Removal: Wastewater Treatment.

Environmental Protection Agency, Washington, D.C, July 1974.
25 p.

Key Words: ammonia, nitrates, nitrites, filtration, adsorption/ion exchange, chlorination.

Abstract:

Each of the processes discussed has its advantages and disadvantages. Unfortunately, no single process for nitrogen removal is superior to others both in terms of performance and economics.

The ammonia-stripping process has the advantage of low cost, removal of ammonia with a minimal addition of dissolved solids, simplicity, and reliability. However, it has the disadvantages of poor efficiency in cold weather and the potential for scaling problems that may reduce its efficiency, and it raises concerns, whether valid or not, over ammonia gas discharge. The new stripping-recovery system overcomes many of these problems, but at the sacrifice of low process costs.

The selective ion exchange process has the advantages of high efficiency, insensitivity to temperature fluctuations, removal of ammonia with a minimal addition of dissolved solids, and the ability to eliminate any discharges of nitrogen to the atmosphere other than nitrogen gas. This process has the disadvantage of relatively high cost, and process control and operation are relatively complex.

The breakpoint chlorination process has the advantages of low capital cost, a high degree of efficiency and reliability, insensitivity to cold weather, and the release of nitrogen as nitrogen gas. It has the disadvantage of adding a substantial quantity of dissolved solids to the effluent in the process of removing the ammonia, it will raise public concerns over handling of chlorine gas, the process controls required are relatively complex, and it requires a downstream dechlorination process.

The relative costs of the physical-chemical nitrogen processes for a 10-mgd plant are:

- Ammonia stripping, 5 cents per 1,000 gallons
- Selective ion exchange, 10-13 cents per 1,000 gallons

Breakpoint chlorination, 11 cents per 1,000 gallons

These costs all are based on the removal of 25 mg/l ammonia nitrogen. The cost of biological nitrogen removal by the three-stage activated-sludge process has been estimated at about 13 cents per 1,000 gallons. Preliminary estimates on the costs of the new ammonia-stripping/ammonia-recovery process discussed earlier, which minimizes the seasonal restrictions on the ammonia-stripping process, indicate that the cost will be 8-10 cents per 1,000 gallons. It can be seen from the above costs that there is little economic incentive to select one process over another if faced with a requirement for cold weather removal of ammonia. The choice must be made by weighing the advantages and disadvantages of each approach in light of the circumstances applicable to a specific project.

Physical-Chemical Wastewater Treatment Plant Design.

Environmental Protection Agency, Washington, D.C., August 1973. 41 p.

Key Words: total organic carbon, adsorption/ion exchange.

Abstract:
This publication gives a good discussion of coagulants used in tertial treatment (polymers, iron salt, aluminum salt, and lime) and gives excellent data on sludge composition.

Pickar, J.H.,M. R. Sochard, J. A. Bellanti, and R. R. Colwell.

Pathogenic Properties of Some Strains of Vibrio parahaemolyticus.

Developments in Industrial Microbiology. 14:337-345. 1973.

Key Words: bacteria, surface water (marine).

Abstract:

Vibrio parahaemolyticus, a food-poisoning agent transmitted via ingestion of contaminated seafood, has been isolated from estuaries in the United States, including Chesapeake Bay. Because of its association with mortalities of shellfish and crabs, as well as its implication in food poisoning in humans, V. parahaemolyticus poses a threat to mariculturists raising crabs, shrimp, and shellfish for market. Since little is known about pathogenesis of this organism, several properties associated with pathogenesis in V. parahaemolyticus were investigated. Determinations of LD_{50} were carried out on mice with three V. parahaemolyticus strains, using whole cell suspensions prepared from 6-hr cultures injected intravenously. Washed cell suspensions and broth filtrates were also tested by intravenous injection. Preliminary physiological evidence suggests the presence of a toxic substance in 36-60 hrs filtrates. The toxicity was less demonstrable when V. parahaemolyticus was administered via the oral route. Pathological changes were observed in selected organs and tissues, they included hepatic plate disruption and liver necrosis. Symptoms observed shortly prior to death from intravenous injection included diarrhea, convulsions, and gasping respiration followed by respiratory failure.

Pietz, R.I., J.R. Peterson, and C. Lue-Hing.

Groundwater Quality at a Strip-Mine Reclamation Area in West Central Illinois.

Metropolitan Sanitary District of Greater Chicago, July 1974. 20 p.

Key Words: cadmium, zinc, chromium, manganese, iron, nitrates, phosphates, chlorides, copper, aluminum, nickel, mercury, groundwater.

Abstract:
The Metropolitan Sanitary District of Greater Chicago (MSDGC) has initiated a program to reclaim an extensive strip-mined area in west central Illinois by recycling digested sewage sludge to rebuild soil and sustain growth of agricultural crops. Part of the environmental protection system established at the Fulton County land reclamation site in 1971 is 24 groundwater monitoring wells situated on both nondisturbed and strip-mined areas. These wells were used to determine base line levels of 23 chemical characteristics before extensive applications of digested sewage sludge in 1973. Groundwater data from six placed land and six mine-spoil monitoring wells, respectively, were selected for statistical analysis of water quality.

Monthly groundwater samples from December 1971 to December 1973 revealed that former strip-mining operations for coal up to 1960 in Pennsylvanian geologic formations had significantly affected the groundwater quality in mine-spoil areas. Electrical conductivity (E.C.), alkalinity, and concentrations of Cl^-, $SO_4^=$, Kjeldahl-N, NH_3-N, K, Na, Ca, Mg, Zn, Cd, Cr, Ni, Mn, Pb, and Fe were significantly higher, at 0.01 level, in mine-spoil groundwaters. In groundwaters from both nondisturbed and mined areas the mean concentrations of NH_3-N, Fe, Pb, Mn, and Zn exceeded public water supply recommendations. Concentrations of Cd, Cr, Ni, Pb, and Zn in mine-spoil waters were approximately two to five times those detected in placed land groundwaters. The frequency of trace metal detection in mine spoil waters was higher than for nondisturbed areas.

Pillay, K.K.S., C. C. Thomas, Jr., J. A. Sondel, and C. M. Hyde.

Mercury Pollution of Lake Erie Ecosphere.

Environmental Research. 5:172-181. May 1972.

Key Words: mercury, surface water (fresh).

Abstract:

The distribution of mercury in the ecosphere of Lake Erie was monitored using a highly sensitive and reliable neutron activation analysis procedure. A variety of samples from the fauna and flora of the lake as well as those from its immediate environment were analyzed for their mercury content. The results of this survey indicate a widespread distribution of mercury in air particulates; coal samples of the region; sediments, plankton/algae, and fish samples from the lake; and in the brain tissues of long-time residents of the Lake Erie Basin.

Pionke, H.B. and G. Chesters.

Pesticide-Sediment-Water Interactions.

Journal of Environmental Quality. 2:29-45. January 1973.

Key Words: pesticides, surface water (fresh).

Abstract:

Pesticide-sediment-water interactions occurring within a water-shed and the associated aquatic system are reviewed regarding their impact on the distribution and persistence of pesticides in recipient lakes. Pesticidal persistence on the watershed is discussed initially because the aquatic residue hazard depends largely on the persistence of soil-applied pesticides. Mechanisms of transport from field to aquatic system are reviewed for those compounds not degraded rapidly to nontoxic derivatives. Pesticide transport through the atmosphere, groundwater, and surface runoff is traced with particular emphasis on application-associated losses and transport effect on initial pesticide distribution and concentration in the aquatic system. Field and plot studies evaluating pesticide losses in runoff are summarized.

Within the aquatic system, limnological, sediment and water characteristics potentially alter the distribution of adsorbed pesticide between water and associated sediment within the lake. Specifically, the effects of pH, lake stratification, characteristics and content of sediment organic matter and clay, and salinity are evaluated. This review concludes with a discussion of literature on pesticide persistence determined in simulated or natural aquatic systems and the interactions between aquatic vegetation, sediment, and water which affect pesticide distribution.

Pitt, W.W., R.L. Jolley, and S. Katz.

Automated Analysis of Individual Refractory Organics in Polluted Water.

Oak Ridge National Laboratory, Oak Ridge, Tennessee, August 1974. 110p. Available from National Technical Information Service (NTIS) as PB-239 774).

Key Words: COD, chlorination.

Abstract:

Residual organic compounds present in municipal sewage treatment plant effluents at microgram-per-liter levels were analyzed using high-resolution anion-exchange chromatography. Effluents were concentrated 50- to 3000-fold by vacuum evaporation and freeze-drying and then analyzed by liquid chromatographs capable of detecting uv-absorbing, oxidizable (with sulfatoceric acid), or carbohydrate constituents. Using techniques such as uv spectroscopy, gas chromatography, and mass spectrometry, 56 organic compounds were identified in primary effluent and 13 organic compounds in secondary effluent. Some of these constituents were quantified. Chromatographic procedures, coupled with radioactive tracer chlorination, were applied to the analysis of chlorinated primary and secondary effluents. A detector system for liquid chromatography based on cerate oxidimetry was adapted as a rapid, sensitive continuous monitor for measuring the COD of waters. The effects of column geometry and operating parameters on chromatographic resolution were studied. Two high-resolution, ion exchange chromatographs (UV-Analyzers) were constructed.

Pitt, W.W, R.L. Jolley, and C.D. Scott.

Determination of Trace Organics in Municipal Sewage Effluents and Natural Waters by High-Resolution Ion-Exchange Chromatography.

Environmental Science and Technology. 9(12):1068-1073. November 1975.

Key Words: COD, chlorination.

Abstract:

Automated, high-resolution ion-exchange chromatographs, previously developed for the analysis of the molecular biochemical constituents in human body fluids, have been applied to the analysis of various polluted waters. Samples of polluted waters have been collected from selected sources, concentrated up to 10,000-fold, and chromatographed on high-pressure ion-exchange columns. Monitoring of the column eluates for ultraviolet absorbance and cerate oxidizability has revealed the presence of numerous organic contaminants, many of which have been subsequently identified by auxiliary techniques such as mass spectrometry. In the primary and secondary effluents from a domestic sewage treatment plant, 56 and 13 organics, respectively, have been identified and quantified. A total of 16 different organics have beeen identified in samples from five different natural waters.

Pittwell, L.R.

Metals Coordinated by Ligands Normally Found in Natural Waters.

Journal of Hydrology. 21:301-304. 1974.

Key Words: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, germanium, iron, lead, manganese, mercury, molybdenum, nickel, selenium, throium, tin, uranium, zinc, surface water (fresh).

Abstract:

Water, carbonate, chloride, and fluoride are the main ligands responsible for keeping metals in solution in natural waters. Metals are listed by ligands and the conditions under which they are likely to be kept in solution are presented in this paper.

Pluntze, J.C.

Health Aspects of Uncovered Reservoirs.

JAWWA. 67(8):432-437. August 1975.

Key Words: bacteria, drinking and recreational water.

Abstract:

There are undeniable health reasons for covering water-supply distribution reservoirs, but it should not be necessary to defend such a project entirely on health grounds. Looping the water-distribution system to eliminate dead ends, hydrant flushing, softening, and iron removal are not designed primarily for health protection. They are intended to improve the quality of the product. A community water supply may meet all health (disease) standards and be entirely unacceptable. It is as if an airline's only mission were to prevent accidents, no matter whether it met schedules or how it treated its passengers. In 1930 that goal may have been foremost, but not today. Of course, water utilities must protect the health of their consumers, but their mission begins, not ends, at that point.

The consumers of community water supplies in the U.S. and Canada readily accept the quality of their water without question. They put great trust in their water utilities and in health agencies, to assure the quality of the product served to them. Sometimes this trust is misplaced. The author has observed previously, as have others, the deficiencies of public water supplies. These deficiencies are not there because water-utility people want them. For the most part, they are not there because utilities are ignorant of current standards and good practice. They are there because consumers have not been shown the problems clearly enough to want changes made. They have not been educated to present-day needs, which must be reflected in present-day rates. On the contrary, they have too often come to believe that water should be free of charge, and that any rate at all is excessive. In the Pacific Northwest, and perhaps elsewhere, they have been taught that the best water is that with the least degree of treatment instead of having the positive results of filtration explained to them.

Water consumers in at least some utilities in 37 states need to be told that covered reservoirs are better than open reservoirs; that the benefits in quality protection and in safeguarding the integrity of the water supply more than merit the cost. There is no better place to start than with AWWA. A strong statement of policy regarding covered distribution reservoirs is needed so that 750 open reservoirs can be covered or phased out - not merely that it is a good idea, but that it is requisite for a truly adequate water utility.

Poduska, R.A. and D.Hershey.

Model for Virus Inactivation by Chlorination.

JWPCF. 44(5):738-745. May 1972.

Key Words: viruses, chlorination.

Abstract:

A mathematical model to explain the process of virus inactivation by chlorination has been developed in this study. The inactivation model is based on the principles of first-order, irreversible chemical reaction kinetics for the reaction between chlorine and virus particles in solution.

The process of inactivation has been found to be dependent on the time of contact between organisms and the chlorine solution, the concentration of chlorine, and the pH of the system. In addition, the process of inactivation is complicated by the fact that viruses may form clumps of various sizes, thereby producing a heterogeneous inactivation system. Each of these factors was included in the model in order to quantify the kinetics of inactivation.

The inactivation data analyzed in this study were that of Poliovirus I and that of Bacteriophages F_2 and MS_2. In the mathematical analysis, all of the clump sizes were numbered from 1 to N, beginning with clump size 1. The model consists of N independent exponential terms that describe the inactivation of each of the clump sizes in a system. An inactivation rate constant is associated with each term and characterizes the rate of inactivation of each clump size.

Pokornts, Y. and K. Kulikova.

Effects of Pesticides on Reservoir Water.

Pesticide Abstracts. 74-1874. 1974.

Key Words: pesticides, bacteria, surface water (fresh), fish.

Abstract:

Studies on the effects of pesticides on the organoleptic and biological properties of reservoir water and on general analytical methods are reviewed. Pesticides may contaminate reservoirs by infiltration or washout from treated farm lands, or by being discharged by pesticide manufacturing plants. Pesticides in water can be determined by colorimetry, gas chromatography, and thin-layer chromatography following extraction and concentration by means of activated carbon or by biological methods using algae, phytoplanktons, and fish as indicators. The odor threshold of most of the pesticides in water lies below 1 mg/liter; that of the major organo-chlorine pesticides varies from 0.13 μg/liter to 22 mg/liter; that of the major organophosphorus pesticides from 0.2 μg/liter to 1 mg/liter. Phenoxyacetic acid derivatives have odor thresholds ranging from 3 μg/liter to 3 mg/liter. The maximum allowable concentration of most of the pesticides, as determined by biological tests, lies below 1 mg/liter, but is as low as about 0.01 mg/liter for such preparations as atrazine, thiometon, and malathion. Bacteria are much more resistent to pesticides than plankton and fish. Agrobacterium spp. decomposed dalapon and Pseudomonas fluorescens decomposed atrazine.

Pollio, F.X. and R. Kunin.

Tertiary Treatment of Municipal Sewage Effluents.

Environmental Science and Technology. 2(1):54-60. January 1968.

Key Words: ammonia, nitrates, chlorides.

Abstract:

The modified Desal process for the renovation of secondary sewage effluents appears to offer a significant advance in processing sewage effluent waters to render them useful for industrial, agricultural, or domestic use. The modified process for sewage water renovation appears to go a step beyond the proposed activated carbon-type tertiary treatment processes, since it brings about simultaneous reduction in both the organic and inorganic mineral contents of the sewage water. During prolonged exposure tests (3 months), processed sewage effluents, with or without additional treatment with the cation exchange resin for ammonium removal, have shown no visual evidence of algae growth. Turbidity was absent, no odor was detectable, and no significant compositional changes have been noted. The problem of pathogens was not investigated. However, there is evidence that chlorination and lime softening do eliminate certain bacterial virus from water during processing.

The process offers much flexibility, since it may be engineered to produce a water for a variety of uses. Where partially processed water is the goal, such that its dissolved ionic and organic contents have been lowered to acceptable levels for direct discharge into streams or waterways, the process possibly could be operated without the flocculation and lime-softening steps; for industrial use, the waters may be sufficiently processed without the added dealkalization step, especially if the secondary treatment (biological) is producing a nitrified effluent. If the sewage plant has not been operated in such a manner, the dealkalization step is required to remove ammonium ions which might prove objectionable.

Presupposing that a cheap source of CO_2 were not available, the economics of operating this modified process would be considerably higher, since recovery of CO_2 is not practical. Fortunately, however, availability of CO_2 should not be a problem, especially in sewage plants which practice secondary treatment. Since the flue gases from the digesters are rich in CO_2, they may be used

directly, after being pressurized, to convert the anion exchange resin (alkalization step) to the bicarbonate form.

In instances where the renovated water will be recycled and renovated more than once, there will be a gradual buildup in ionic solids. During each renovation, if the dealkalization step is not incorporated into the process, sodium ions tend to accumulate if not removed. This situation can be avoided by dealkalizing the waters totally or partially every other cycle or two, depending on the extent of the sodium ion buildup and the required end use for the renovated water.

Disposal of waste regenerant from the ion exchange units and sludge from the flocculation and lime-softening treatments should present no problem. These could be readily combined with the solid waste from secondary treatment and disposed of using the normal practice of the sewage treatment plant.

Polson, R.L.

Refractory Metals Processing Waste Utilization on Dayton Silty Clay Loamy Soil.

Oregon State University, Corvallis, 1976. 159p.

Key Words: aluminum, iron, manganese, copper, nickel, zinc, lead, cobalt, molybdenum, ammonia, fluorides, nitrates, nitrites, phosphates, agriculture, groundwater, crops.

Abstract:

Refractory metal-processing wastes were applied to soil and perennial rye-grass was grown. The waste additions did not affect the yield of rye-grass. Trace metal uptakes by the plants were not significantly affected by waste application. It was felt that fluoride pollution of groundwaters could be a significant threat.

Poon, C.P.C.

Studies on the Instantaneous Death of Airborne *Escherichia coli*.

American Journal of Epidemiology. 84(1):1-9. July 1966.

Key Words: Escherichia coli, air.

Abstract:

The postulated mechanism of instantaneous killing of airborne bacteria was once again demonstrated in this experiment. The rate of death of airborne *E. coli* was found directly proportional to the rate of water evaporation. A modified Fuch's equation for water evaporation can be applied directly to the rate of death of bacterial aerosols.

Foreign material associated with bacterial aerosols affects the rate of death of airborne bacteria by changing the rate of water evaporation from within cells.

Poon, C.P.C.

Viability of Long-Storaged Airplane Bacterial Aerosols.

Journal of the Sanitary Engineering Division, ASCE.
94(SA6):1137-1146. December 1968.

Key Words: bacteria, air.

Abstract:

For bacterial aerosols suspended in the air for a long storage time, the following conclusions can be made:

1. Increase of air temperature will increase the death rate of airborne cells.

2. Decrease of relative humidity will increase the death rate.

3. The rate of water evaporation still plays an important role in the viability of airborne cells as is found in the case of instantaneous death of bacterial aerosols.

4. The viability of airborne bacteria is affected by the presence of chemcial additives due to their effects upon water evaporation.

5. Bacterial aerosols from sewage treatment plants can survive a long time due to the presence of chemical additives. This should be considered as a potential hazard to public health.

Porcella, D.B., J.S. Kumagai, and E.J. Middlebrooks.

Biological Effects on Sediment-Water Nutrient Interchange.

Journal of the Sanitary Engineering Division, ASCE.
96(SA4):911-926. August 1970.

Key Words: phosphates, surface water (marine).

Abstract:

The microcosm experiments were designed to show that the productivity of low phosphorus waters would be affected by the presence of sediments which could act as a source of phosphorus for the growth of algae. It was found that the different types of sediments varied in their ability to support algal growth and that this was related to the amount of available phosphorus measured in the sediments. Although the amount of phosphorus released from the sediments varied with the type of sediment, it seemed apparent that all of the available phosphorus eventually would be extracted in the 15 cm layer of sediment studied in these microcosms. The total depth of sediment in a natural lake which could serve as a source of phosphorus is yet unknown.

The microcosms had a 10 day residence time and a ratio of four volumes of water to one of sediment and hence represent natural situations only in a rough way. However, one would conclude that the effects on productivity in a natural lake by the removal of phosphate from waste waters would not be observed until the reservoir of available phosphorus in the sediment of the lake was exhausted.

The development of a thick mat of Oscillatoria causes an increase in productivity due to the increased transfer of phosphorus from the sediment. The mat of algae apparently has the following effects: the development of anaerobic conditions in the sediments serves as the growing point of the blue-green algae which produces the blooms observed in the overlying waters, causes disruption and therefore better mixing of the sediments and pore water with the overlying water, and is a source of organic materials secreted by the algal cells which may in turn serve as substrates for other microorganisms. Most probably transfer of phosphorus from the sediments is enhanced not only by the increased solubilization of phosphorus in the sediments caused by the algal mat and the conditions the mat produces, but also by the effects on equilibrium between water and sediment by the continual accumulation of phosphorus from solution by the growing algae.

The role of an Oscillatoria mat in nature would be greatest in shallow lakes where light penetrated to the bottom, allowing development of the population of algae on the sediment surface. Because blue-green algae are inhibited by strong light, it would be expected that most of the growth would occur under conditions where dim light existed. The development of algal mats has been observed to occur in nature and it may be that a considerable amount of algal growth occurs on the surface of sediments in natural lakes and that the effects of phosphorus in the sediments on algal growth as observed in the microcosms would also occur in nature.

In general, the more productive systems had sediments containing greater amounts of phosphorus. Also, the equilibration of ^{32}P with stable phosphate occurred more rapidly in the more productive systems, and this rate of equilibration appeared to be associated with the sediments themselves. Therefore ^{32}P exchange with stable P was related to the concentration of available phosphorus in the system. One might speculate that the rate of ^{32}P removal from solution after the initial rapid decrease indicates that transfer (by diffusion or other mechanisms) through the sediment column occurs at a relatively rapid rate (on the order of days).

The effect of organic matter on the rate of phosphorus solubilization and transfer from sediments to the overlying water also should be evaluated. The results described previously were not definitive but it is possible that the effect of organic materials would be to increase the phosphorus release from sediments by serving as a substrate for anaerobic bacteria which in turn would cause a lowering of sediment pH and increased solubilization of phosphates. Because of the development of anaerobic conditions in the sediments of both aerobic and anaerobic reactors, it was not possible to compare differences in solubilization or transfer of phosphorus as a function of the oxygen status of the microcosms. It was expected that anaerobic conditions would lower the redox potential and lower the pH and that both of these reactions could lead to the release of phosphorus. However, under these experimental conditions the aerobic solubilization of phosphorus cannot be evaluated because even in the aerobic microcosms the sediments were anaerobic.

Portmann, J.E.

Disposal of Sewage Sludge to Sea: United Kingdom Experience and Practice.

In: Pretreatment and Ultimate Disposal of Wastewater Solids. A. Freiberger, ed. EPA-902/9-74-002, Environmental Protection Agency, Region II, New York, 1974. pp. 331-348.

Key Words: general, surface water (marine).

Abstract:

The disposal of sewage sludge by dumping at sea has been conducted from the United Kingdom for well over seventy years. The quantities of sludge disposed of in this way are steadily increasing, both in volume and with regard to the number of sources. Although in some areas limited accumulation of both organic matter and persistent substances has occurred, the extent to which this has taken place is small. The main reason for this limited effect is probably to be found in the adequate dispersion characteristics in relation to the quantities disposed of in the areas in question.

Disposal by dumping at sea of sewage sludges, and indeed wastes of industrial origin, from the United Kingdom will undoubtedly continue for the foreseeable future. However, the quantities which can be approved will continue to be related to the capacity of the area to receive wastes. The quantity can be estimated from a knowledge of current movements and the polluting characteristics of the waste, e.g. its oxygen demand, and its nutrient, metal. and PCB content. Careful monitoring must of course be conducted to ensure that these predictions are accurate and that the capacity of the area to receive a waste is not pushed beyond its limit.

From this it should not be assumed that the sea may be used for the disposal of any waste which proves difficult or expensive to dispose of on land. Nor should the total capacity of an area to receive wastes be fully utilized. There must be some reserve of capacity to ensure that other uses of the area can continue. It is clear, however, that with care the sea can be used for the disposal of many waste materials and that in some respects it may offer advantages over land disposal, as currently conducted, although as new methods of treatment recovery or disposal (e.g. by incineration) are developed these may in turn be adopted in preference to sea disposal. At the present time, however, sewage sludge is a bulky waste with a high water content which proves difficult to dispose of on land but which with care can often be safely disposed of to sea.

Posselt, H.S. and W.J. Weber, Jr.

Removal of Cadmium from Waters and Wastes by Sorption on Hydrous Metal Oxides for Water Treatment.

In: Chemistry of Water Supply, Treatment, and Distribution. A.J. Rubin, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1975. pp. 89-108.

Key Words: cadmium, adsorption/ion exchange.

Abstract:

Removal of trace amounts of cadmium ($< 10^{-6}$M) from drinking water supplies is highly desirable in view of the low levels at which toxic effects are manifested by this metal. Sorptive uptake of cadmium on suitable solid materials would constitute a method easily adaptable to present water treatment technology. Accordingly, the sorption behavior of hydrous oxides of Al(III), Fe(III), and Mn(IV) towards cadmium was examined over a wide range of variable conditions.

The equilibrium uptake of cadmium on the sorbents studied can be described well by the Langmuir equation for sorption. Sorption rates observed with highly dispersed hydrous oxides are extremely rapid, with equilibrium usually being attained in less than 10 minutes.

Both the limiting sorption capacity (X_m) and adsorption affinity (b) for cadmium tend to increase over the pH range beyond the pH of ZPC for all three oxides studied. Hydrous manganese dioxide, prepared by careful reduction of permanganate, was found superior on the basis of Langmuir parameters and by virtue of its low ZPC value. The practical range for Al(III) salts is rather limited due to the formation of aluminate ion and a relatively high ZPC for insoluble Al(III) hydrolysis products.

The sorption of cadmium exhibits a small dependence on ionic strength. Competitive effects from uptake of calcium or from chloride complexation are similarly weak in magnitude. These results suggest that sorption on hydrous oxides of Mn(IV) and Fe(III) is a feasible approach for removal of cadmium in water and wastewater treatment.

This work and related studies indicate that the sorptive behavior of hydrous oxides is greatly influenced by the age and mode of preparation of these materials. Investigation of these aspects may prove very fruitful from the standpoint of optimizing the efficiency of

sorptive processes on a separate basis or in combination with coagulation processes.

Furthermore, the chemical and structural resemblance between hydrous manganese dioxide and "silica" suggests similar sorptive properties for the latter material. Since the use of silica as coagulant aid in water treatment has already been established, an examination of its role as a potential sorbent for heavy metal ions appears worthwhile.

Pound, C.E. and R.W. Crites.

Characteristics of Municipal Effluents.

In: Recycling Municipal Sludges and Effluents on Land; Proceedings of the Joint Conference, July 9-13, 1973. pp. 49-61.

Key Words: suspended solids, BOD, COD, oil and grease, coliforms, influent characteristics, combined municipal and/or industrial systems.

Abstract:

Physical, chemical, and biological characteristics of municipal wastewaters are presented and discussed with respect to land application. Both constituents of raw wastewater as well as effluents from four types of plants are included. These constituents are compared to those of acceptable irrigation waters and to the relative amounts of each that would normally be applied to the land. The objective of this comparison is to put irrigation with municipal effluents into perspective. On the basis of the data presented and the corresponding literature review, several areas of research are outlined.

Pound, C.E. and R. Crites.

Wastewater Treatment and Reuse by Land Application. 2 vols.

Metcalf and Eddy, Inc., Palo Alto, California, August 1973.

Key Words: BOD, suspended solids, nitrates, phosphates, nitrites, cadmium, iron, manganese, zinc, copper, protozoa, parasiteic worms, viruses, coliforms, polio virus, salmonella, shigella, ponding/land application, crops.

Abstract:

A nationwide study was conducted of the current knowledge and techniques of land application of municipal treatment plant effluents and industrial wastewaters. Selected sites were visited and extensive literature reviews were made (annotated bibliography will be published separately).

Information and data were gathered on the many factors involved in system design and operation for the three major land application approaches: irrigation, overland flow, and infiltration-percolation. In addition, evaluations were made of environmental effects, public health consideration, and costs--areas in which limited data are available.

Irrigation is the most reliable land application technique with respect to long term use and removal of pollutants from the wastewater. It is sufficiently developed so that general design and operational guidelines can be prepared from current technology.

Overland flow was found to be an effective technique for industrial wastewater treatment. Further development is required to utilize its considerable potential for municipal wastewater treatment.

Infiltration-percolation is also a feasible method of land application. Criteria for site selection, groundwater control, and management techniques for high rate systems need further development.

Prakasam, T.B.S. and R.C. Loehr.

Microbial Nitrification and Denitrification in Concentrated Wastes.

Water Research. 6:859-869. July 1972.

Key Words: ammonia, nitrates, nitrification/denitrification.

Abstract:

The feasibility of removing nitrogen from a concentrated nitrogenous waste by microbial nitrification and denitrification is investigated. Continuous flow and batch studies have been conducted to investigate the effect of the various parameters that affect the process of nitrification. A solids retention time of greater than two days and a range of loading factors between 0.15-0.84 #COD day^{-1} #$MLVSS^{-1}$ resulted in 45-60 percent nitrification of the total Kjeldahl nitrogen contained initially in the waste. The level of inhibition of nitrification due to free NH_3 and undissociated HNO_2 is discussed. The control of pH was found to be unnecessary either in nitrification or denitrification of the waste. Denitrification of the nitrified waste resulted in complete elimination of the oxidized nitrogen formed in the nitrification stage; nevertheless, residual ammonia contained initially in the mixed liquor persisted. A second nitrification of this denitrified mixed liquor resulted in complete oxidation of the residual ammonia.

Prasad, D. and P.H. Jones.

Degradation of Organic Nitrogenous Compounds by Psychrophilic Bacteria.

JWPCF. 46(7):1686-1691. July 1974.

Key Words: bacteria, activated sludge.

Abstract:

1. Temperature exerts an important regulating influence on the rate of metabolism.

2. Amino acids, urea, and creatinine are degraded by phychrophilic bacteria at low temperature.

3. Psychrophiles are not able to metabolize egg albumin at low temperature.

4. Low temperatures seem to induce certain changes in some aspect of cellular organization in psychrophilic bacteria.

5. Conventional biological waste treatment processes can operate at low temperatures provided a long detention time is allowed.

6. Psychrophiles play an important role in the stabilization of organic wastes in the biological waste treatment processes.

Pratt, P.F.

Aluminum.

In: Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 3-12.

Key Words: aluminum, ponding/land application,
land reclamation, groundwater, crops.

Abstract:
Plant and soil criteria useful in diagnosing aluminum status, including visual symptoms and leaf analysis are described; the toxicity of aluminum in nutrient solutions is discussed and corrective measures, as well as suggested analytical methods are proposed.

Pratt, P.F.

Chromium.

In: Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 136-141.

Key words: chromium, ponding/land application, land reclamation, groundwater, crops.

Abstract:

The author discusses visual symptoms of chromium excess and tissue analysis values, as well as soil criteria useful in diagnosing chromium status.

Pratt, P.F.

Vanadium.

In: Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 480-483.

Key Words: vanadium, groundwater, crops.

Abstract:

There are no problems associated with vanadium deficiency or toxicity under field conditions.

Preliminary Assessment of Suspected Carcinogens in Drinking Water: Appendices to Interim Report to Congress.

U.S. Environmental Protection Agency, Washington, D.C., Office of Toxic Substances, June 1975. 214p. (Available from National Technical Information Services (NTIS) as PB-244 416).

Key Words: pesticides, synthetic/organics, arsenic, beryllium, chromium, nickel, selenium, nitrates, drinking and recreational water.

Abstract:

This is an assessment of suspected carcinogens in potable water; sources, treatment techniques, and health effects are discussed.

Preliminary Assessment of Suspected Carcinogens in Drinking Water. Interim Report to Congress.

U.S. Environmental Protection Agency, Washington, D.C., Office of Toxic Substances, June, 1975. 39p. (Available from National Technical Information Service (NTIS) as PB-244 415).

Key Words: chlorinated hydrocarbons, synthetic/organics, organo-nitrogen pesticides, organo-phosphorous pesticides, chlorides, drinking and recreational water.

Abstract:

This is an assessment of suspected carcinogens in potable water sources, treatment techniques, and health effects are discussed.

Preliminary Investigation of Effects on the Environment of Boron, Indium Nickel, Selenium, Tin, Vanadium, and Their Compounds. Vol. I: Boron.

Versar, Inc., Springfield, Virginia, August 1975. 120p. (Available from National Technical Information Service (NTIS) as PB-245 984).

Key Words: boron, groundwater, surface water (fresh), surface water (marine), crops, livestock, food processing, fish, direct contact, shellfish, drinking and recreational water.

Abstract:

This article gives a complete review of the environmental effects of boron and its compounds (sources, pathways, toxicity, etc.).

Preliminary Investigation of Effects on the Environment of Boron, Indium Nickel, Selenium, Tin, Vanadium, and Their Compounds. Vol. IV: Selenium.

Versar, Inc., Springfield, Virginia, August 1975. 192p. (Available from National Technical Information Service (NTIS) as PB-245 987).

Key Words: selenium, gravity separators, groundwater, surface water (fresh), surface water (marine), crops, livestock, food processing, fish, direct contact, drinking and recreational water, shellfish.

Abstract:

This is a complete review of the environmental effects of selenium and its compounds (sources, pathways, toxicity, etc.).

Premi, P.R. and A.H. Cornfield.

Incubation Study of Nitrogen Mineralization in Soil Treated with Dried Sewage Sludge.

Environmental Pollution. 2(1):1-5. July 1971.

Key Words: ammonia, activated sludge, agricultural sludge disposal.

Abstract:

The delay in nitrification, particularly where 2% sludge had been added, indicates that a factor (possibly organic) which was inhibitory to nitrification and contained in the added sludge, was operative early in incubation, but the inhibitory factor decreased with time. Alternatively, delayed nitrification may have been due to the relatively high content of ammonium-nitrogen in the soil-sludge mixture (particularly where 2% sludge was applied) combined with high pH resulting in temporary inhibition of the activity of nitrifying organisms. Delayed nitrification in this soil at pH 7.5 when treated with 100 ppm ammonium-nitrogen was observed. The increased levels of copper, zinc, and chromium due to sludge treatment were not likely to have delayed nitrification. Researchers have found that the addition of sulphates of these three elements in amounts twice as high as those introduced here had no significant effects on nitrification. EDTA-extractable values in this experiment showed that less than 58% of the zinc, 25% of the copper and about 1% of the chromium was present in active form. The last element is probably retained in an inactive anionic form.

The relatively low recovery of added organic nitrogen in mineral form even after six weeks of incubation at 30°C is typical of bulky organic manures of low nitrogen content. It was found under these incubation conditions that the extent of mineralization of organic nitrogen in soils is similar to that which occurs during an average growing season in field soils in southern England. The ammonium-nitrogen in the sludge contributed about as much to the nitrogen status of the soil as did that which mineralized in time from the organic nitrogen compounds present.

Another researcher found that the organic nitrogen in heat-dried sludges (probably similar to the material used in this study) mineralized slowly in soils, and sometimes caused nitrogen deficiency to crops. The subject study showed no evidence of even a temporary immobilization of mineral nitrogen due to sludge treatment at any level.

Pressley, T.A., D.F. Bishop, and S.G. Roan.

Ammonia-Nitrogen Removal by Breakpoint Chlorination.

Environmental Science and Technology. 6(7):622-626. July 1972.

Key Words: ammonia, chlorination.

Abstract:

Breakpoint chlorination in buffered aqueous solutions of 20 mg/l of NH_3-N in the pH range of 5.0-8.0 oxidized the ammonia chiefly to N_2 with only small amounts of NO_3- and NCl_3 also formed. During chlorination, monochloramine concentrations increased with chlorine dose through about a 5:1 wt ratio of Cl:NH_3-N and then decreased to zero at the breakpoint. Only traces of $NHCl_2$ occurred in the 5-8.0 pH range with less than 0.1 mg/l above pH 7. Potential products of N_2O, O_2 (from the decomposition of N_2O), NO, and NO_2 did not occur. The minimum chlorine dosage for the breakpoint of less than 8:1 wt ratio of Cl:NH_3-N occurred in the range of pH 6-7.

The amount of NO_3- produced at the breakpoint increased from about 1.5% of the NH_3-N at pH 5 to about 10% at pH 8.0 in the aqueous systems. In contrast, the NCl_3 production at the breakpoint decreased from approximately 1.5% of the NH_3-N at pH 5 to 0.25% at pH 8.0. In the 2-hr contact time of the study, breakpointing at temperatures of 5-40°C did not change the amounts of the products or the required chlorine dose.

In the pH range of 6.5-7.5, breakpoint chlorination of ammonia in wastewaters oxidized 95-99% of the ammonia to nitrogen gas. When chlorine demands other than ammonia were minimized by pretreatment (lime-clarified secondary effluent), the chlorine dosages (8:1 wt ratio of Cl:NH_3-N) required for the breakpoint approached the stoichiometric (7.6:1 wt ratio) dosage to oxidize ammonia to N_2. Residuals of NO_3- and NCl_3 were also formed in the wastewaters but with initial NH_3-N concentrations of 8-15 mg/l, the NO_3-N residual never exceeded 0.5 mg/l at the breakpoint; and the NCl_3-N residual never exceeded 0.5 mg/l.

Preston, A.

Heavy Metals in British Waters

Nature. 242:95-97. March 1973.

Key Words: zinc, iron, manganese, cobalt, nickel, lead, cadmium, surface water (marine).

Abstract:

In this article, the author establishes levels of heavy metals in seawater for iron, zinc, manganese, cobalt, nickel, lead, and cadmium.

Preul, H.C.

Underground Movement of Nitrogen.

Munich Abstracts - Section I. 38(3):335-336. March 1966.

Key Words: ammonia, nitrates, iodides, groundwater.

Abstract:

In the vicinities of the 11 waste stabilization ponds investigated, concentrations of ammonia were found to be less than about 3 mg/l NH_4-N within 20 ft (6.1 m) from the edge of the pond. However, concentrations of nitrate in the groundwater surrounding the ponds were found to be less than 1.0 mg/l NO_3-N as far out as 150 ft (46 m) from the ponds. Consequently, the ponds are not seen as a serious threat in the nitrate contamination of groundwater.

Preul, H.C.

Underground Movement of Nitrogen.

Advances in Water Pollution Research. 1966(1):309-328.

Key Words: nitrates, nitrites, ammonia, groundwater.

Abstract:

Several pertinent observations may be made from the information presented relative to the movement of nitrogen in a shallow soil adsorption system.

1. Biological oxidation is the dominant mechanism affecting ammonia nitrogen as it passes through the soil. This action occurs at a high rate initially and to a large extent within several feet of the point of release of the septic tank effluent where soil conditions are well aerated.

2. Nitrate contamination of groundwaters is a serious threat from shallow soil absorption systems. High concentrations of ammonia nitrogen in septic tank effluents are quickly nitrified to high concentrations of nitrate which pollute the groundwater. Dilution from groundwater or soil moisture and possibly denitrification aid in the deterrence of nitrate.

3. The effectiveness of adsorption in deterring the travel of nitrogen is limited because of the rapidity of conversion from NH_4 to NO_3. Laboratory experiments have shown than NH_4 can be removed readily in soil by adsorption but, under aerated soil circumstances, nitrification of these ions occurs before the flow can contact a sufficiently effective volume of soil.

Pringle, B.H.

Water Reuse in the United States.

Aerospace Medical Research Laboratory, Wright-Patterson AFB, Ohio, December 1974. 17p. (Available from National Technical Information Service (NTIS) as AD-A011 856).

Key Words: drinking and recreational water.

Abstract:

This article is a general discussion of water reuse with goals that must be met to ensure public health well-being.

Pringle, B.H., D.E. Hissong, E.L. Katz, and S.T. Mulawka.

Trace Metal Accumulation by Estuarine Mollusks.

Journal of the Sanitary Engineering Division, ASCE.
94(SA3):455-475. June 1968.

Key Words: cadmium, cobalt, chromium, copper, iron, manganese, lead, nickel, zinc, aluminum, antimony, arsenic, barium, beryllium, boron, germanium, mercury, molybdenum, selenium, uranium, surface water (fresh), surface water (marine), fish.

Abstract:

Mollusks in the natural estuarine environment appear to accumulate trace metals at different rates and attain tissue levels according to the environmental concentration of the particular metal, the temperature, the species concerned, as well as the physiological activity of the animal itself.

When the environmental concentration of a particular toxic trace metal persists over a sufficient period of time, the animal may become affected physiologically by the metal accumulation to such an extent that it becomes nonfunctional or dies.

The apparent selectivity for trace metals among various molluscan species appears to depend to a considerable extent upon the metals available in the environment; their chemical and physical properties; the kind and number of ligands available for chelation, transport, and storage; and the stability of the complex formed. The relative toxicities of the various metals also play a prominent role.

In a simulated natural environmental system the accumulation rates, as well as the tissue levels of the trace metals, are dependent upon the environmental metal concentration, the temperature, the time of exposure, and the particular species used.

The relative toxicity of a particular metal varies from species to species for any given concentration, all other factors remaining constant.

The studies reported herein generally show that for any given metal and set of experimental conditions, the uptake rate and tissue concentration level decreased for the following species in the order given: Soft-shell Clam, _Mya arenaria_; American Eastern Oyster, _Crassostrea virginica_; and the Northern Quahaug, _Mercenaria mercenaria_.

The four environmental levels of lead used in the anatomical accumulation studies gave identical results as to the concentration order for all the anatomical areas studied. The following anatomical areas are given in the order of their increasing lead accumulation (concentration): muscle, mantle edge, mantle, remainder, gill, gonad, and digestive gland. The accumulation rates doubled as the environmental level of lead used throughout the duration of the experiment was doubled.

Considerable toxicity was exhibited towards the animals exposed to the higher environmental levels of lead (0.1 ppm and 0.2 ppm). This was particularly evident regarding the gonadal area of the oyster.

Depletion of trace metals follow biochemical turnover within the animal, and must be expected to be a slower process than is the release of cellular material. From the data presented herein, it appears that metals are depleted (at least lead) at a faster rate by the American Eastern Oyster than they are by the Northern Quahaug, but slower than is the case for the soft-shell clam. In addition, there appears to be a direct relationship between the uptake rate for a given metal and its depletion for any molluscan species. The initial tissue level of any given metal appears to be directly related to the depletion rate for any given species.

Process Design Manual for Nitrogen Control.

U.S. Environmental Protection Agency, Washington, D.C., October 1975. 464p.

Key Words: ammonia, nitrification/denitrification.

Abstract:

This manual discusses the various design alternatives for control of nitrogen in wastewater.

Process Design Manual for Sludge Treatment and Disposal.

EPA-625/1-74-006, Black, Crow and Eidsness, Inc., Gainesville, Florida, October 1974. 418p. (Available from National Technical Information Service (NTIS) as PB-259 151).

Key Words: zinc, copper, nickel, cadmium, viruses, bacteria, Escherichia coli, Salmonella typhosa, heavy metals, BOD, COD, anaerobic digestion, aerobic digestion, heat treatment, composting, incineration, landfill.

Abstract:

This is a document that has been developed by EPA to aid in the design of wastewater sludge treatment and disposal facilities. Topics discussed include thickening, stabilization, conditioning, reduction, and final disposal practices.

Prothero, G.L.

Nitrogen and Heavy Metal Distribution in Soils Utilized as Sludge Disposal Sites.

Oregon State University, Corvallis, 1976. 145p.

Jey Words: cadmium, chromium, copper, manganese, nickel, zinc, nitrates, nitrites, groundwater, crops, sanitary landfill.

Abstract:

Metropolitan areas today must dispose large volumes of sewage sludge produced during the wastewater treatment process. This research was conducted to study the effect of large applications of municipal sewage sludge on (a) the distribution of N and trace elements (Cd, Cr, Cu, Mn, Ni, Zn) in the soil profile, (b) the uptake of these elements by plants growing on the sludge-treated soil, and (c) the potential for groundwater contamination.

Quality of Coastal Waters: Second Annual Progress Report.

Water Resources Research Center, University of Hawaii, Honolulu, 1973. 275p.

Key Words; cadmium, chromium, cobalt, copper, iron, manganese, nickel, mercury, aluminum, zinc, ammonia, chlorides, nitrates, nitrites, suspended solids, total dissolved solids, total organic carbon, DDT, DDD, DDE, dieldrin, chlorinated hydrocarbons, herbicides, pesticides, surface water (marine), surface water (fresh).

Abstract:
An investigative and evaluative work to identify, develop, and evaluate the critical physical, biological, and rational parameters needed in formulating effective policies, institutions, and systems for protecting the quality of coastal waters, this is a study of heavy metals, pesticides, herbicides, and nutrients in the bay sediments, stream sediments and watershed soils.

Radding, S.B., B.R. Holt, J.L. Jones, D.H. Liu, and T. Mill.

Review of the Environmental Fate of Selected Chemicals.

Stanford Research Institute, Palo Alto, California, January 1975. 44p. (Available from National Technical Information Service (NTIS) as PB-238 908).

Key Words: synthetic /organics, surface water (fresh), surface water (marine).

Abstract:

Any attempt to quantify losses of a specific product during manufacture or use as an intermediate will require a major effort because of such factors as the wide variations in: (1) production processes, (2) product purification, and (3) product intermediate and end uses. The minimum information required for such an undertaking would be detailed process flow sheets and material balances, together with reaction kinetics data and mixture component vapor pressures and solubilities as a function of temperature and solution composition. The effectiveness of air, water, and solid waste pollution control measures at plant sites should also be examined with some field verification of theoretical losses.

Very few references were found that were of much value in providing rate data for evaluation, and the need for such reliable data has been noted for each compound. The general fate of these compounds in the environment and their toxic effects other than the carcinogenic properties have received little attention in the literature. Basic physical data are frequently unavailable and environmental measurements wholly so. Inferences concerning environmental movement are consequently fragmentary. At best, we can eliminate several of the compounds as probable hazards in freshwaters, but can say little with confidence regarding their decomposition products or their behavior in saltwaters. Nor can we fully appraise their potential biotic impacts, although several compounds are clearly mutagenic as well as carcinogenic. Table 1 summarizes the findings of this report:

To efficiently utilize available resources, it is recommended that the following sequence of steps be taken:

- Quantify the losses to the environment of the more biologically significant compounds

- Determine the basic physical and chemical properties as related to environmental processes (i.e., oxidation, hydrolysis)
- Reappraise the potential environmental mobility of each compound
- Determine the toxicity, mutagenicity, and teratogenicity of those which appear most hazardous on the basis of mobility and magnitude of release.

Radiation for a Clean Environment.

International Atomic Energy Agency, Vienna, 1975. pp. 139-149.

Key Words: viruses, bacteria, radiation treatment.

Abstract:

The experiments presented here represent preliminary results on the biological effectiveness of high-energy electron treatment of municipal sludge. Positive conclusions include the requirement for blending of raw sludge for maximum effectiveness of the electron beam. Introduction of oxygen in raw sludge leads to increased microbial inactivation. The use of intermittent oxygenation permits a lowering of the treatment dose.

Future experiments will expand these findings, and in addition, studies on the inactivation of animal viruses in raw sludge will be initiated. The current status of viruses and ionizing radiation in respect to wastewater treatment has been reviewed by Lemke and Sinskey, and the removal of viruses from sewage, effluents and waters has been recently reviewed by Berg.

Preliminary experiments conducted in cooperation with T. Metcalf, University of New Hampshire, United States of America, have shown that animal viruses (poliovirus type II, reovirus type I, Coxsackievirus B3 and adenovirus type 5) have similar radiation sensitivities, and in addition are more resistant than the bacterial virus P22 reported here.

Changes in physical properties of raw sludge as well as the chemical oxygen demand due to electron irradiation are also being investigated.

Radioactivity in the Marine Environment.

Panel on Radioactivity in the Marine Environment of the Committee on Oceanography National Research Council/ National Academy of Sciences, 1971. 28p.

Key Words: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, germanium, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thorium, tin, uranium, zinc, surface water (marine), fish, shellfish.

Abstract:

This is a textbook on marine chemistry and the uptake of radionucleides by fish and shellfish.

Ragone, S.E., J. Vecchioli, and H.F.H. Ku.

Short-term Effect of Injection of Tertiary Treated Sewage on Iron Concentration of Water in Magothy Aquifer, Bay Park, New York.

In: Preprints of Papers Presented at the International Symposium on Underground Waste Management and Artificial Recharge. J. Braustein, ed. G. Banta, Menasha, Wisconsin, 1973. 1:273-290.

Key Words: iron, surface water (fresh), chemical treatment.

Abstract:

Tertiary-treated sewage (reclaimed water) has been recharged by a deep well into the Magothy aquifer, the primary water-supply source for Nassau County, Long Island, New York. As of September 1972, 12 recharge tests have been run since the inception of the recharge program in September 1968. Although the iron concentrations of reclaimed and native water averaged 0.44 mg/l and 0.24 mg/l, respectively, the iron concentration of the mixed (native and reclaimed) water at times exceeded 3 mg/l. Several sources can account for the increase in iron concentration, but the most probable source is the pyrite that is native to the Magothy aquifer. During recharge, the natural reducing condition in the aquifer is replaced by a progressively more oxidizing environment. The initial response to this change is the oxidation of pyrite, which released Fe^{+2}, SO_4^{-2}, and H^+ into solution. Eventually, ferric hydroxide precipitates, and the Fe^{+2} concentration decreases. The exact oxidation mechanism apparently involves inorganic and (or) organic constituents in the reclaimed water, because water from the public potable water-supply system that is injected into the acquifer does not cause an increase in iron concentration.

Rains, B.A., M.J. DePrimo and T.L. Groseclose.

Odors Emitted from Raw and Digested Sewage Sludge.

Saint Louis Metropolitan Sewer District, December 1973.
76p. (Available from National Technical Information
Service (NTIS) as PB-232 369).

Key Words: synthetic/organics, adsorption/ion exchange, gravity thickeners, air.

Abstract:

This study was undertaken to identify typical odor causing substances and evaluate selected conventional methods for controlling or eliminating these substances. A styrofoam dome covering a sludge thickener was used to control atmospheric conditions and concentrate odors. Field collected vapor samples were analyzed using gas chromatography techniques. Analyses using both polar and nonpolar column material indicated that the major odor causing compounds were mercaptans and amines. Other compounds which were minor contributors to odor were aldehydes, alcohols, and organic acids. Odor control methods selected for study included air dilution, activated carbon adsorption, and chlorine oxidation. Air dilution using cyclic operation of an exhaust fan was an effective means of odor control when outside atmospheric conditions were conducive to odor dissipation. Passing vapors through activated carbon filters was not completely effective in odor control since a detectable residual odor remained.

Raj, H.D. and F.E. Swatek.

Ecological Study of Bacteria and Fungi from Deep Well Waters.

California State University at Long Beach, 1964. 41p.

Key Words: Vibrio cholerae, fecal streptococci, Staphylococcus aureus, Clostridium welchi, coliforms, bacteria, groundwater, surface water (fresh), direct contact (air), shellfish, drinking and recreational water.

Abstract:
This paper describes original research on bacteria and fungi endemic to potable water storage sites.

Rall, D.P.

PCB's - Environmental Impact.

Environmental Research. 5:253-352. September 1972.

Key Words: chlorinated hydrocarbons, surface water (fresh), surface water (marine).

Abstract:

This is an excellent review on the movement of PCB's in the environment.

Ramchandran, M., M.I.D. Sharma, S.C. Sharma, P.S. Mathur,
A. Aravindakshan, and M.G.J. Edward.

DDT and Its Metabolites in Human Body Fat in India.

Bulletin of the World Health Organization. 49(6):637-638. 1973.

Key Words: DDT, DDE, epidemiology.

Abstract:

DDE and the o,p'- and p,p'-isomers of DDT were assayed in 94 human biopsy fat samples from hospitals in Delhi by gas chromatography. DDT was present in all except 2 samples at concentrations from 0.17 to 176.5 mg per kg of body fat. The average total DDT content was 21.8 ± 2.9 mg/kg, of which 45.9% was DDE. The average value reported in a similar study in 1965 (24.3 mg/kg, of which DDE constituted 39.7%) was not significantly different from the present value, indicating that the DDT storage status has not since undergone any significant change.

Randall, A.D.

Movement of Bacteria from a River to a Municipal Well - A Case History.

JAWWA. 62(11):716-720. November 1970.

Key Words: bacteria, drinking and recreational water, groundwater.

Abstract:

This paper makes a strong case for coliform bacteria reaching the Endicolt Stable Well from the Susquehanna River and advances an explanation consistent with available data. Several general inferences can be drawn from this study.

1. Although bacteria in river water are normally removed by filtration through riverbed and aquifer materials, they can move at least 180 ft to a municipal well under some conditions.

2. Waterworks managers who wish to maintain bacteria-free well water should avoid riverbed excavations in the immediate vicinity of the wells, or if unavoidable, should insure that the backfill is relatively impermeable. Of course, the quality of the river water must be considered in evaluating the risk.

3. Riverbank wells already deriving a large part of their water from nearby induced infiltration, as shown by large seasonal temperature fluctuations, are the most susceptible to bacterial pollution in the event of riverbed excavation or increased withdrawal rates.

4. Many municipalities in northeastern United States are, or could be, supplied by water pumped from sand and gravel aquifers along major streams and derived in large part from induced infiltration. As river-to-well gradients become steeper and stream channels are relocated, dredged, and perforated for various purposes, all wells can hardly be expected to continue to produce raw water of perfect sanitary quality. Most municipal well-water distribution systems provide chlorination adequate to protect the water from sporadic or incidental pollution, but the design of many systems does not permit the detention time necessary for excess chlorination and removal, which should be used if water persistently contains numerous bacteria. New installations should allow for eventual addition of such treatment if needed.

Ratkowsky, D.A.

A Numerical Study of the Concentration of Some Heavy Metals in Tasmanian Oysters.

Journal of the Fisheries Research Board of Canada. 31:1165-1171. July 1974.

Key Words: zinc, cadmium, copper, shellfish.

Abstract:

Inferential techniques of numerical classification and principal coordinate analysis have been used to interpret data obtained on the Zn, Cd, and Cu concentration of 48 samples of oysters, comprising 473 individuals, grown at a variety of places around the Tasmanian coastline. A close association was obtained between proximity to heavily urbanized areas and concentration of metals found, oysters growing nearest urban areas having the highest concentrations of one or more of the metals. It appears that areas for commercial oyster growing should be sought in regions far from centers of urbanization and industrialization. Examination of samples of native oysters could be useful in providing an index or measure of environmental pollution.

Ratzan, K.R., J.A. Bryan, J. Krackow, G. Meyer, and C.D. Larson.

An Outbreak of Gastroenteritis Associated with the Ingestion of Raw Clams.

Journal of Infectious Diseases. 120(2):265-268. 1969.

Key Words: viruses, hepatitis virus, shellfish.

Abstract:

The report describes an outbreak of acute gastroenteritis associated with the ingestion of raw clams and the results of surveillance to detect subsequent cases of infectious hepatitis.

The epidemic case occurred in New Haven, Connecticut, November 16, 1968.

Raymont, J.E. and J. Shields.

Toxicity of Copper and Chromium in the Marine Environment.

Advances in Water Pollution Research. 1962 (3):275-290.

Key Words: chromium, copper, surface water (marine), shellfish.

Abstract:
These investigations suggest that with Nereis a toxic threshold exists for copper at a level of about 0.1 ppm Cu, but that chromium is less poisonous, the threshold approaching ten times this value. The few experiments conducted with the crab Carcinus, indicate that copper is at least ten times, and possibly nearer twenty times, more toxic than chromium; with Leander copper appears to be also more poisonous.

Reay, P.F.

The Accumulation of Arsenic from Arsenic-Rich Natural Waters by Aquatic Plants.

Journal of Applied Ecology. 9:557-565. August 1972.

Key Words: arsenic, surface water (fresh).

Abstract:

The paper discusses accumulation of arsenic by aquatic plants in a freshwater system.

Rebhun, M. and J. Manka.

Classification of Organics in Secondary Effluents.

Environmental Science and Technology. 5(7):606-609. July 1971.

Key Words: synthetic/organics, effluent characteristics.

Abstract:

The composition of soluble organics in secondary effluents was investigated. A fractionation procedure was applied enabling recovery and quantitative determination of humic substances as well as other chemical groupings present in secondary effluents. This procedure made possible the classification of the total organic content of secondary effluents. Forty to 50% of the organics was classified as humic substances (humic, fulvic, and hymathomelanic acids), the fulvic acid being the major fraction of this class. The remainder of the organic matter consisted of (in percent): ether extractables, ∼ 8.3; anionic detergents, ∼ 13.9; carbohydrates, ∼ 11.5; proteins, ∼ 22.4; and tannins, ∼ 1.7.

Recycling Sludge and Sewage Effluent by Land Disposal.

Environmental Science and Technology. 6(10):871-873. October 1972.

Key Words: phosphates, boron, suspended solids, BOD, coliforms, iron, aluminum, crops, adsorption/ion exchange, groundwater, influent characteristics.

Abstract:

This is a very general article that discusses the potential of applying both sludge and effluent to land.

Reed, S.

Wastewater Management by Disposal on the Land.

Special Report 171. Corps of Engineers, U.S. Army.
Hanover, New Hampshire, May 1972. 183p.

Key Words: ammonia, BOD, COD, phosphates, cadmium, chromium, copper, lead, manganese, nickel, zinc, chlorides, suspended solids, effluent characteristics, ponding/land application, land reclamation.

Abstract:

This article is an excellent write-up and overview of land disposal. Discussions include land disposal operating parameters as well as associated health effects.

Reeves, T.G.

Nitrogen Removal: A Literature Review.

JWPCF. 44(10):1895-1908. October 1972.

Key Words: ammonia, nitrates, adsorption/ion exchange, nitrification/denitrification.

Abstract:

Review of the physical, chemical, and biological processes available for nitrogen removal shows that current technology is at a stage where in most instances a biological process must be selected if nitrogen removal is necessary or a nitrified effluent must be produced. Air stripping of the ammonia cannot yet be considered practical because of its cost and the two problems encountered: precipitation of carbonates and the biological oxidation of ammonia to nitrates in the towers. Also, in some locations, the ammonia released may present an air pollution problem or the ammonia will be reabsorbed in the water.

Ion exchange may be feasible in smaller plants, but it is difficult to envision this method of nitrogen removal's becoming popular. Many operational difficulties have been encountered, including fouling of the resins, plugging, and disposal of the backwash brine. The most practical method available is biological nitrification-denitrification. A three-stage system will be needed in most locations, including a carbonaceous BOD removal unit (high-rate trickling filter or high-rate activated sludge), nitrification (aerobic) unit, and a denitrification (anaerobic) unit. Also, a small air stripping unit would be helpful to remove the nitrogen gas. There are three available denitrification units which could be used: anaerobic activated sludge, anaerobic filter system, and an anaerobic lagoon. The lagoon method would probably be best except for the problem of re-aeration of the effluent.

Reid, G.W., R.Y. Nelson, C. Hall, U. Bonilla, and B. Reid.

Effects of Metallic Ions on Biological Waste Treatment Processes.

Water and Sewage Works. 115(7):320-325. July 1968.

Key Words: chromium, copper, nickel, zinc, BOD, trickling filters.

Abstract:

1. Laboratory studies on the effect of metallic ions on attached slimes on drums showed that no adverse effect was noted for the concentrations of Cr^{+6}, Cd, and Cu studied. The biological treatment of domestic sewage will not be adversely effected if the Cr^{+6} concentration is not allowed to exceed 2 mg/1.

2. The effect of metallic ions on the Tinker AFB pilot plant showed that domestic sewage containing 2 mg/1 or less of Cr^{+6} does not significantly effect the BOD removal efficiency.

3. Trace amounts of metallic ions will be removed by trickling filters. The more effective the filter's removal of domestic BOD, the more effective its removal of the metallic ion.

4. Cr^{+6} in concentrations to be expected at Tinker AFB will not significantly reduce the digester operational efficiency. The introduction of floc in trace amounts will also not greatly effect operations.

Reid, S.C., *et al*.

Pretreatment Requirements for Land Application of Wastewater.

Extended Abstract for ASCE Second National Conference on
Environmental Engineering Research, Development, and Design.
University of Florida, July 1975.

Key Words: ammonia, nitrates, total organic carbon, BOD, coliforms, chlorides, cadmium, copper, nickel, lead, zinc, ponding/land application, groundwater.

Abstract:

This is a general discussion on the land application of wastewater.

Reimers, R.S. and P.A. Krenkel.

Kinetics of Mercury Adsorption and Desorption in Sediments.

JWPCF. 46(2):352-365. February 1974.

Key Words: mercury, surface water (marine).

Abstract:

1. At a constant pH value, the adsorption of inorganic mercury is definitely affected by the chloride concentration with a 20 to 100 percent loss in capacity, depending on the constituents of the sediment (sands, clays, or organics). The only exceptions to this conclusion are the organics containing amines or mercaptans.

2. For the materials used, the uptake rate and capacity of inorganic mercuric chloride is given in the following order:

R - SH >> Illite >Montmorillonite

$>R - NH_2$ >Kaolinite $> R- \overset{\overset{O}{||}}{C} - OH$

>Fine Sand >Medium Sand

> Coarse Sand

3. Four materials found in natural sediments were observed to absorb methyl mercury, and they absorbed in the following order:

R - SH >> Illite >Montmorillonite
>Fine Sand

4. The fact that the amine and carboxyl groups are ineffective in binding with methyl mercury raises some questions about recent EPA reports indicating the use of an organic film or fiber not containing sulfhydryl groups for the inhibition of mercury pollution in the field. The amines and carboxyl groups also have a lower capacity for binding inorganic mercury than do the natural clays, illite, and montmorillonite.

5. Because inorganic mercury binds with sands, clays, and various organics, the contention that mercury pollution is transported in our water systems by sediments is supported. For example, the appearance of mercury contamination in Kentucky Lake, which is over 100 river miles from mercury contaminated Pickwick Lake, the only known source of mercury in the system, can be explained on this basis.

Reimold, R.J. and C.J. Durant.

Toxaphene Content of Estuarine Fauna and Flora Before, During, and After Dredging Toxaphene-Contaminated Sediments.

Pesticides Monitoring Journal. 8(1):44-49. June 1974.

Key Words: chlorinated hydrocarbons, surface water (marine), shellfish.

Abstract:

This paper evaluates toxaphene concentrations in selected estuarine fauna, flora, sediment, and dredge spoil before, during, and after the dredging of Terry Creek, Brunswick, Ga., in autumn 1972. This is the second effort to widen the channel of the creek, which receives the effluent from a nearby toxaphene-manufacturing plant; a 1971 dredging effort was aborted by the State of Georgia. The current study employed safeguards inspired by the 1971 State action: enclosure of dredge spoil in diked areas of unproductive marshland to prevent runoff, and weekly monitoring of Terry Creek biota and sediment to detect the possible role of toxaphene in any resulting disturbance to the balance of nature. Monitoring of dredge spoil, fauna, and flora showed toxaphene concentrations to be higher during dredging than before or after. Eastern oysters (*Crassostrea virginica*), reported to be among the best biological monitors, did not demonstrate large changes in toxaphene content resulting from the dredging. The high toxaphene concentration in oysters ranged between 2.0 and 5.0 ppm. The best indicators evaluated were salt marsh cordgrass (*Spartina alterniflora*) and mummichog (*Endulus heteroclitus*). The highest content found in *S. alterniflora* was 7.5 ppm; the highest concentration in *F. heteroclitus* was over 200 ppm.

Reinert, R.E., L.J. Stone, and W.A. Willford.

Effect of Temperature on Accumulation of Methylmercuric Chloride and p, p' DDT by Rainbow Trout (Salmo gairdneri).

Journal of the Fisheries Research Board of Canada. 31:1649-1652. October 1974.

Key Words: mercury, DDT, fish.

Abstract:

Amounts of mercury and DDT residues accumulated from water by yearling rainbow trout (Salmo gairdneri) in the laboratory increased as water temperature increased. Fish exposed to methylmercuric chloride at concentrations of 234-263 parts per trillion for 12 weeks at 5, 10, and 15 C accumulated 1.19, 1.71, and 1.96 ppm; fish exposed to p,p' DDT at concentrations of 133-176 parts per trillion accumulated 3.76, 5.93, and 6.82 ppm. Concentrations of mercury accumulated by the fish were significantly different ($P< 0.01$) at each of the three temperatures, and the concentrations of DDT were significantly different at 5 and 10 and 5 and 15C. Throughout the period of exposure, the concentration factors (concentration of contaminant in the fish/concentration in water) at each of the three temperatures were far higher for p,p' DDT than for methylmercuric chloride.

Reinhardt, A.W., D.P. Spath, and W.F. Jopling.

Organics, Water, and Health: A Reuse Problem.

JAWWA. 67(9):477-480. September 1975.

Key Words: COD, groundwater.

Abstract:

Groundwater recharge through surface spreading is also employed by the Orange County Water District, on the lower reach of the Santa Ana River. In 1972-73, more than 70,000 acre-ft of river water was recharged. The river contains an average of approximately 35 mg/l of COD, a large percentage of which is believed to be of sewage origin. This operation introduces more than 8 million pounds of organic material to the groundwater basin.

Remsen, C.C., E.J. Carpenter, and B.W. Schroeder.

Competition for Urea among Estuarine Microorganisms.

Ecology. 53(5):921-926. Late Summer 1972.

Key Words: ammonia, surface water (marine).

Abstract:

Phytoplankton were responsible for the major part of the urea decomposition in the Savannah-Wilmington-Ogeechee estuaries and adjacent coastal waters in Georgia. This is an exception to the general rule that bacteria are favored over algae in the competition for dissolved organic compounds. Filtration of estuary water through a 20-µ mesh filter did not significantly change the concentration of urea-decomposing bacteria; there was, however, a significant change in phytoplankton cell concentrations, chlorophyll α, and urea decomposition rates. Thus, any differences in the decomposition of urea in filtered and unfiltered aliquots could be attributed to the phytoplankters removed by filtration. Average cell concentrations and chlorophyll α removed by filtration was 15% and 39% of the totals, respectively. However, the removal of urea-decomposing activity averaged 53% of the total. This indicates that the phytoplankters removed by filtration, mainly diatoms with large cross-sectional areas such as rhizosolenia, chaetoceros, asterionella, thalassiosira, etc., were responsible for proportionally higher amounts of urea decomposition than would be indicated on a purely cell-numbers basis.

Urea concentrations ranged from 0.6 to 8.9 µM, with the highest values (average 3.41 µM) being found in the more polluted Savannah estuary. Lower values, generally 1-2 µM, were observed in the Wilmington and Ogeechee estuaries. Fresh water generally had slower urea decomposition rates (average 6.2 mµmoles liter^{-1} hr^{-1}) than brackish waters (average 19.6 mµmoles liter^{-1} hr^{-1}). Turnover times for urea, calculated from these average values, was 25 days for fresh water and 4 days for brackish water.

Report of the Secretary's Commission on Pesticides and Their Relationship to Environmental Health.

Department of Health, Education and Welfare, Washington, D.C., December 1969. 694p.

Key Words: DDT, DDE, other (general) pesticides, dieldrin, aldrin, endrin, direct contact (air), surface water (fresh).

Abstract:

This document presents an extensive evaluation of all available evidence on the benefits and risks of using pesticides. The report examined pesticide uses and benefits, contamination potential, effects on nonhuman target organisms, effects on man, carcinogenicity, interactions, mutagenicity, and teratogenicity. Of particular importance were Chapter 4: Effects of Pesticides on Man, and Chapter 5: Carcinogenicity of Pesticides. The report indicated that pesticide effects varied widely; DDT is not an acute poison, while dieldrin and lindone have caused serious poisoning. Lindane may be responsible for hematological disorders. Organophosphates and carbamates are acute toxins, although neither accumulate in the body as do the organochlorines (DDT, dieldrin, etc.).

There is no evidence to indicate that pesticides are carcinogenic to man, although some do cause tumors in experimental mammals. The pesticides may enhance the effects of other carcinogens.

The report concludes that our knowledge of the effects of pesticides on man is at best fragmentary and for the most part, indirect and inferential.

Report on Hepatitis of the Safety Committee of the California Water Pollution Control Association.

JWPCF. 37(12):1629-1634. December 1965.

Key Words: hepatitis virus, groundwater.

Abstract:

On the basis of reviewed literature and case studies, it is not possible to show any significant relationship between the incidence of infectious hepatitis and employment at a wastewater treatment plant. Disease transmission by the more usual means is considerably more likely as a cause of infection of even wastewater treatment plant employees.

If the plant operator remains conscious of the fact that he is working with potentially hazardous material, develops good personal hygiene habits, maintains a clean plant, and uses good common sense, he will protect himself and others from accidental infection.

Reported Morbidity and Mortality in the United States.

Morbidity and Mortality Weekly Report Annual Supplement Summary 1975. U.S. Center for Disease Control, HEW, 24(54). August 1976.

Key word: epidemiology.

Abstract:

This annual summary of reported morbidity and mortality in the U.S. in 1975 reported cases of disease covered by international quarantine agreement and cases of specified notifiable diseases from 1966-1975.

Research Foundation to Undertake Study on Organics Removal.

Watercare. San Jose, California, September 1975. 7p.

Key Words: synthetic/organics, adsorption/ion exchange.

Abstract:

Ten water utilities will be selected to actively participate in a survey of trace organic chemicals present in their water. A monthly sampling program of water from these systems will be carried on during a one year period. Organic matter will be collected using both the carbon adsorption method (CAM) samplers recommended in the 14th edition of Standard Methods and the resin extraction (RE) samplers developed by Svec and his co-workers. The CAM samplers employ activated carbon whereas the RE samplers employ polymeric adsorbents.

Both samplers will be used in collecting organic matter from the raw water and treated water from each supply. Water samples from the distribution system will be obtained using the RE samplers only. Organic matter extracted from the adsorbent will be analyzed at a central analytical laboratory to identify the trace organic chemicals present in the highest concentration, humic and fulvic acids being excluded.

One of the ten water utilities will be selected for a demonstration project in which a side-by-side comparison of treatment using granular activated carbon, powdered activated carbon and polymeric adsorbents will be made. The demonstration project will be carried on for one year so that effects related to seasonal variations in water quality can be investigated. No attempt to reactivate either the granular or the powdered carbon will be made, although it is recognized that the performance of a full scale treatment process employing granular activated carbon in particular will depend in part upon whether virgin materials are used exclusively or only as replacement material for carbon lost in reactivation.

A short-term bench scale comparison of granular activated carbon, powdered activated carbon and polymeric adsorbents will precede the demonstration project. The bench scale tests will aid in the selection of specific materials to use in the pilot plant and in providing a basis for determining which of several available regenerants should be selected for use in regenerating the polymeric adsorbents.

Reuther, W. and C.K. Labanauskas.

Copper.

In: Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 157-179.

Key Words: copper, ponding/land application, land reclamation, groundwater, crops.

Abstract:

The role of copper in agriculture has been the subject of much careful study. The authors give some historical background and then describe plant criteria useful in diagnosing copper status detailing visual symptoms of copper deficiency and excess, soil criteria useful in diagnosing copper status with soil analysis values of significance as well as specific values for copper in soils. They also discuss copper excess and its control and the control of copper deficiency. They conclude with a discussion of the relation of copper deficiency in plants and animals, its symptoms and control.

Rice, C.P. and H.C. Sikka.

Fate of Dieldrin in Selected Species of Marine Algae.

Bulletin of Environmental Contamination and Toxicology.
9(2):116-123. February 1973.

Key Words: dieldrin, surface water (marine).

Abstract:
This article describes the uptake of dieldrin by algae.

Richardson, C.J., J.A. Kadlec, W.A. Wentz, J.P.M. Chamie, and R.H. Kadlec.

Background Ecology and the Effects of Nutrient Additions on a Central Michigan Wetland.

University of Michigan, Ann Arbor, Michigan, 1975. 52p.

Key Words: ammonia, nitrates, nitrites, phosphates, surface water (fresh).

Abstract:

This is a study to test the feasibility of wetlands to remove nutrients from secondarily treated sewage wastewater, and to determine the magnitude of any changes in the structure and function of the wetland ecosystem.

Richardson, E.W., E.D. Stobbe, and B. Bernstein.

Ion Exchange Traps Chromates for Reuse.

Environmental Science and Technology. 2(11):1006-1016.
November 1968.

Key Words: chromium, adsorption/ion exchange.

Abstract:

The pilot plant tests showed that an ion exchange system could be used to recover the chromates discharged from a recirculating cooling water system and, thus, to help maintain the chromate concentration at an acceptable level for discharge into surface streams. The chromate concentration was reduced from 20 ppm to an average of less than 1 ppm as $C_RO_4=$, while the concentration of the other dissolved salts remained essentially unchanged.

Rickert, D.A. and J.V. Hunter.

Effects of Aeration Time on Soluble Organics during Activated Sludge Treatment.

JWPCF. 43(9):134-138. January 1971.

Key Words: COD, total organic carbon, activated sludge.

Abstract:
The effects of aeration time on soluble organic parameters were studied during conventional activated sludge treatment. On three occasions a plug flow of primary effluent was sampled over a 6-hr aeration period. The following observations were made:

1. Soluble TOC was reduced to a relatively stable level after 30 min of aeration. The reduction of initial concentration averaged 70 percent.

2. Soluble COD was reduced to a relatively stabel level after 1 hr of aeration. The reduction of initial concentration averaged 77 percent.

3. COD:TOC ratios decreased steadily over the first hour of aeration and fluctuated irregularly thereafter.

4. Over the aeration interval from 30 min to 1 hr, the COD:TOC ratio decreased while the TOC concentration remained constant. This combination of events suggested the transfer of soluble organics between the aqueous phase and bacteria.

5. The estimated net increase in the mean oxidation state of soluble carbon averaged 1.61 units after 1 hr and 1.67 units after 6 hr of aeration. Thus, over 96 percent of the apparent oxidation occurred within the first hour of treatment.

Riemer, D.N. and S.J. Toth.

Adsorption of Copper by Clay Minerals, Humic Acid and Bottom Muds.

JAWWA. 62(3):195-197. March 1970.

Key Words: copper, surface water (marine).

Abstract:
The adsorption of Cu from $CuSO_4 \cdot 5H_2O$ solutions by H-Al forms of leaolinite, illite, montmorillonite and humic acid was studied in the laboratory. The adsorption and release of Cu from three pond sediments were also examined. The most important findings were:

1. All of the clay minerals and humic acid used completely adsorbed the small amounts of $CuSO_4 \cdot 5H_2O$ that are normally used to control algae.

2. Based on the absolute amounts of Cu adsorbed, the clay minerals and humic acid could be arranged in the following descending order:

humic acid> montmorillonite> illite> kaolinite

3. Copper sulfate applications to ponds are fixed by the bottom, and the factors controlling the fixation are: nature of clay minerals, clay content, organic matter content and, in cases of calcareous bottoms, the percentage of limestone present.

4. The amount of water soluble Cu present in pond bottoms can be reduced to very low values by air-drying the bottom sediment.

5. The fixation percentages of Cu ranged from 17.5 to 28.7 percent in the three pond sediments used in this study.

Riley, J.P. and G. Skirrow.

Chemical Oceanography. Vol. 1.

Academic Press, New York, 1965. 626p.

Key Words: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, germanium, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thorium, tin, uranium, zinc, surface water (marine).

Abstract:

This is a reference book on marine chemistry.

Riley, J.P. and G. Skirrow.

Chemical Oceanography. Vol. 2.

Academic Press, New York, 1965. 667p.

Key Words: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, germanium, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thorium, tin, uranium, zinc, surface water (marine).

Abstract:
This is a reference book on marine chemistry.

Risebrough, R.W.

PCB Residues in Atlantic Zooplankton.

Bulletin of Environmental Contamination and Toxicology.
8(6):345-355. December 1972.

Key Words: chlorinated hydrocarbons, surface water (marine).

Abstract:

This article discusses the accumulation of PCB in zooplankton.

The Rising Clamor about PCB's.

Environmental Science and Technology. 10(2):122-123. February 1976.

Key Words: chlorinated hydrocarbons, food processing, fish, livestock, shellfish, drinking and recreational water.

Abstract:

This is a basic review of PCB problems (ecological), and alternatives to PCB use.

Rivers, J.B., J.E. Pearson, and C.D. Shultz.

Total and Organic Mercury in Marine Fish.

Bulletin of Environmental Contamination and Toxicology.
8:257-265. August 1972.

Key Words: mercury, fish.

Abstract:

This article determines the total and organic mercury levels in the fish muscle tissue of certain pelagic and inshore fish of Hawaii which are used for human consumption.

Rizzo, J.L. and R.E. Schade.

Secondary Treatment with Granular Activated Carbon.

Water and Sewage Works. 116(8):307-312. August 1969.

Key Words: suspended solids, BOD, COD, total organic carbon, adsorption/ion exchange.

Abstract:

Experimental work completed at Rocky River indicates that a granular activated carbon process can treat the plant's waste beyond that possible with conventional bacteriological processes commonly referred to as secondary treatment. In addition, it indicates that granular activated carbon can be utilized for treatment of clarified raw sewage, in place of conventional biological secondary treatment.

Roan, S.G., D.F. Bishop, and T.A. Pressley.

Laboratory Ozonation of Municipal Wastewaters.

District of Columbia Department of Environmental Services, Washington, D.C., September 1973. 47p. (Available from National Technical Services (NTIS) as PB-231 380).

Key Words: COD, ammonia, nitrates, nitrites, ozonation.

Abstract:

Raw wastewater, secondary effluent, lime clarified and filtered raw and secondary wastewaters, carbon treated wastewaters, and breakpoint chlorinated plus carbon treated wastewaters were ozonated at pH 7.0 over a range of 5-90 minutes contact time. Ozonation of the raw wastewater, with high solids and COD content required impractical ozone dosages for appreciable COD removal. In all effluents, except raw wastewater, 100 mg/l of ozone produced at least a 70% COD removal. Organic oxidation efficiencies in the raw and secondary wastewaters, based upon one atom of available oxygen per molecule of ozone, exceeded 100% indicating that one or more atoms of the ozone molecule or molecular oxygen participated in the organic oxidation mechanism. Variable amounts of organic nitrogen and ammonia were oxidized at pH 7.0 by ozone to nitrate. The ozone distribution ratio between oxidation of the NOD and COD, and the COD removals as a function of ozone dose suggested that the relative order of oxidation was easily oxidizable organic material, NH_3, TKN, and slowly oxidizable (nearly refractory) organic material.

Robbins, J.W.D., D.H. Howells, and G.J. Kritz.

Stream Pollution from Animal Production Units.

JWPCF. 44(8):1537-1544. August 1972.

Key Words: nitrates, total organic carbon, groundwater, surface water (fresh).

Abstract:

The state of the art of animal waste management is primitive. The extent of water pollution caused by farm animal production units is almost entirely dependent on the production and waste management practices utilized by farmers rather than on the volume of wastes involved.

The use of anaerobic lagoons as the sole means for treatment of animal wastes is an unsatisfactory practice in areas where rainfall exceeds evaporation. The practice of dumping fresh animal wastes directly into streams causes excessive pollution and should be prohibited. The natural pollutional load on streams draining agricultural basins devoid of farm animals can be appreciable under certain conditions of rainfall and runoff, and should be taken into consideration in water quality management. Because the soil provides natural treatment of animal wastes, land spreading is a very effective means to minimize water pollution.

Groundwater problems associated with properly located and managed animal production sites appear to be minimal.

Robeck, G.G., N.A. Clarke, and K.A. Dostal.

Effectiveness of Water Treatment Processes in Virus Removal.

JAWWA. 54(10):1275-1292. October 1962.

Key Words: polio virus, filtration, chemical treatment, ponding/land application.

Abstract:

Small-scale pilot plants were used to study the removal of poliovirus Type I from water as it passed through unsaturated or water-saturated sand at groundwater movement rates and through a flocculation-filtration process at rapid rates. Some erratic results with rapid rates indicate that more testing is necessary to resolve design and operating problems with any modified treatment processes.

The principal findings on both phases of work over a 20-month period were:

1. Two feet of clean, well-packed sand removed poliovirus from water that was flowing at less than 4 ft per day, and the percentage removed gradually decreased until most of the organisms went through at rapid filtration rates.

2. If a low but well-mixed dose of alum was fed just ahead of the filters operated at 6 or 2 gpm/sq ft, more than 98 percent of the viruses were removed by 16 in of coarse coal on top of 8 in of sand. Sand alone did as well, but filter runs were shorter than they were with the mixed media.

3. If the alum dose was increased and conventional flocculators and settling were used, the removal was increased to over 99 percent.

4. With alum fed just ahead of the filters, the length of time for a run or floc breakthrough varied with raw-water turbidity, floc strength, temperature, and rate of filtration. Successful 1-day runs, however, were experienced at 6 gpm/sq ft when the raw-water turbidity was about 10 Jackson units or less.

5. When a turbid water was treated, a floc breakthrough was usually accompanied by an increase in virus penetration even though the finished water turbidity remained below 0.5 Jackson unit. Polyelectrolyte doses as low as 0.05 ppm increased the floc strength and helped to prevent such breakthroughs.

6. When relatively clear water was treated, the virus penetration increased without a corresponding increase in filter effluent turbidity. This was especially true when 5 instead of 10 ppm of alum was used.

Roersma, R.E., G.J. Alsema, and I.H. Anthonissen.

Removal of Hexavalent Chromium by Activated Carbon.

Chemical Abstracts. 83:65112w. 1975.

Key Words: chromium, adsorption/ion exchange.

Abstract:

The treatment of Cr^{6+} containing effluents by reduction to Cr^{3+} with activated carbon is described. The Cr^{6+} is adsorbed in the pores of the activated carbon which is slowly oxidized to CO_2. The evolved gas expels the Cr^{6+} from the pores, and the reaction ceases. The reaction rate increases with temperature, Cr^{6+} concentration, and the amount of activated carbon present. At a Cr^{6+} concentration of 40 g/l, 9% of the theoretically possible reduction is obtained.

Rogers, C.J. and R.L. Landreth.

Degradation Mechanisms: Controlling the Bio-accumulation of Hazardous Materials.

National Environmental Research Center, Cincinnati, Ohio, January 1975 21p. (Available from National Technical Information Service (NTIS) as PB-240 748).

Key Words: chlorinated hydrocarbons, surface water (fresh), surface water (marine).

Abstract:

The mechanisms for degradation of hazardous materials in nature are chemical, biological, and photodegradation processes. Many hazardous materials are destroyed by these naturally occurring processes but at rates too slow to prevent significant and unwanted accumulation in living systems. Because natural transformation of certain hazardous materials often leads to the synthesis of a compound more toxic than the parent chemical compound, nonbiodegradable structures can result in detectable and potentially harmful bioaccumulation in living systems. Therefore, safe technologies for resource recovery and waste disposal should be developed and implemented to minimize the undesirable release of hazardous materials into the environment.

Rohatgi, N.K. and K.Y. Chen.

Fate of Metals in Wastewater Discharge to Ocean.

Journal of Environmental Engineering Division, ASCE. 102(EE3): 675-685. June 1976.

Key Words: cadmium, chromium, copper, iron, lead, manganese, nickel, zinc, location.

Abstract:

Trace metals with sewage and sludge particulates from the City of Los Angeles Hyperion Treatment Plant are found to mobilize to a great extent from solids to seawater in the ocean environment. The fate of these metals and the amount of annual transport to the ocean are evaluated, based on: (1) concentrations of trace metals in the wastewater particulates; (2) sediment metal concentrations in the proximity of sewer outfalls; (3) the degree of metal release from wastewater particulates upon mixing and dilution with seawater under laboratory conditions; and (4) the settling velocity of sewage and sludge particulates. More than 90% of trace metals, such as cadmium, copper, lead, nickel, and zinc in the sludge particulates are solubilized through biochemical reactions. A higher degree of solubilization from the mixture of primary and secondary effluents is observed.

Rohatgi, N. and K.Y. Chen.

Transport of Trace Metals by Suspended Particulates on Mixing with Seawater.

JWPCF. 47(9):2298-2316. September 1975.

Key Words: manganese, cadmium, copper, nickel, lead, zinc, suspended solids, chromium, iron, surface water (fresh), surface water (marine), effluent characteristics.

Abstract:

Under aerobic conditions with seawater salinity, trace metals were observed to be released from suspended particulates, especially in the cases of Cd, Cu, Ni, Pb, and Zn. The release of trace metals was observed to occur in two stages: an initial rapid release, followed by a slower, long-term release. Release of trace metals may be attributed to (a) the oxidation of organic matter or metal sulfides; (b) desorption from SS, which depend mostly on the dilution ratio and pH of seawater; and (c) the formation of metal chloride as well as organo-metallic complexes.

Results on the release of trace metals from the suspended particulates of wastewater effluents, sludge, and dry weather flow from the Los Angeles River are listed in this study. In most cases, Cd, Cu, Ni, Pb, and Zn were found to be released to a greater extent than the rest. Chromium, Fe, and Mn were not found to be released except in the case of digested sludge, in which 2 percent of the chromium and 35 percent of manganese were found to be released from solid phases.

The Role of Soils and Sediments in Reducing the Concentration of Heavy Metals, Fluorides, and Pesticides in Percolating Waste Discharges (Memorandum Report).

State of California Resources Agency, Department of Water Resources, Sacramento, June 1972. 30p.

Key Words: pesticides, ponding/land application, groundwater, fluorides.

Abstract:

The persistence and movement of pesticides within soils is related directly to the extent of adsorption, which, in turn, is dependent on the solubility of pesticides, the exchange capacity of the soil, and the grain size and distribution of the soils. Other factors include: (1) the microbial degradation of pesticides; and (2) chemical degradation that may be due to hydrolysis or precipitation reactions within the soil system. Factors that affect reactions of pesticides within the soil medium are pH value within the soil medium and the temperature of the soil medium. Some of the pesticides persist within the soil medium; they can be desorbed from the clays and colloidal soil fractions under the right pH and temperature conditions. Other factors that affect the movement of pesticides within the soil are volatilization of the pesticide and its movement in the vapor phase and plant uptake. Much more information is needed about particular types of pesticides and on the fate of these pesticides.

Rolfe, G.L., A. Chakar, J. Melin, and B.B. Ewing.

Modeling Lead Pollution in a Watershed-Ecosystem.

Journal of Environmental Systems. 2:339-349. December 1972.

Key Words: lead, surface water (fresh).

Abstract:

An interdisciplinary study is currently in progress at the University of Illinois at Urbana-Champaign under a grant from the National Science Foundation RANN Program. Objectives of the study include understanding and modeling the movements and effects of heavy metals (initially lead) in the environment.

A model has been constructed which simulates the movements and predicts the accumulation points of lead in a 76-square mile watershed-ecosystem in Champaign County, Illinois. The model includes components of both aquatic and terrestrial ecosystems and represents the ecosystem by a network of nodes and branches where the nodes represent the components of the ecosystem in a general sense and the branches indicate possible transport mechanisms between nodes. Results of a two year simulation using a network of 36 nodes and 121 branches is presented.

The model provides a method for the study of pollutant transport and accumulation in ecosystems.

Romero, J.C.

The Movement of Bacteria and Viruses Through Porous Media.

Ground Water. 8(2):34-48. March-April 1970.

Key Words: viruses, bacteria, groundwater, ponding/land application.

Abstract:

This report is the result of a request by the State Board of Examiners of Water Well and Pump Installation Contractors. The Board is in the process of formulating a more reasonable set of guidelines which control the location of wells designed to produce water for human consumption and/or food processing with respect to potential or existing sources of groundwater pollution.

The pollution of groundwater supplies is artfully treacherous. It appears belatedly and often is not recognized until a relatively large area has been contaminated and perhaps one or more individual water supplies have been rendered unfit for human consumption. It is known that soils and aquifer materials have capacity to remove or "filter" some types of contaminants, and something is also known of the limitations in this regard. It is with these thoughts upon which this report is based. The report is designed to briefly describe the results of several pertinent groundwater pollution investigations and present current and potential standards for governing "safe distances" between domestic-food processing wells and sources of potential or existing pollution. The recommendations are meant to emphasize the fact that no one set of distances is adequate and reasonable for ALL conditions. Whenever possible, the "safe distance" between a subject well and a source of potential or existing pollution should be based on local conditions.

It is important that we develop knowledge that will permit continued use of the soil mantle as a wastewater treatment system and at the same time permit continued use of groundwater for human consumption and for food processing. Functional legal, administrative and engineering mechanisms must be developed to maintain this combined usage.

Rook, J.J.

Formation of Haloforms during Chlorination of Natural Waters.

Water Treatment and Examination. 23:234. 1974.

Key Words: surface water (fresh), chlorination.

Abstract:

There is strong evidence that haloforms are produced by chlorination of humic substances in natural waters. Whether these have any physiological effects requires further study.

If it can be established that haloforms are harmful, then it may be necessary to restrict the chlorination of coloured waters or to remove haloforms by, for example, volatilization by intensive aeration of the treated water.

Rook, J.J. and G. Oskam.

Biological and Chemical Aspects of Rhine Water in the Berenplaat Reservoir.

JAWWA. 62(4):249-259. April 1970.

Key Words: chlorides, total dissolved solids, surface water (fresh).

Abstract:

Since 1966 the Rotterdam Waterworks has operated a storage reservoir, in which the heavily polluted Rhine water is stored during a relatively short period.

Primary aim, when constructing this reservoir, was covering of periods in which the river water was of poor quality, with additional quality improvement by selfpurification processes.

Because of its fertility the stored Rhine water supports a heavy growth of algae during most of the growing season (March to November). The seasonal pattern of algal pulses was approximately identical in all three years. Except for the month of June, the algal population is dominated by diatoms, with Asterionella formosa reaching highest numbers.

The restricted detention period does not allow the plankton to complete a full life-cycle. The algae are withdrawn from the reservoir with the abstracted water, while still in the logarithmic growth phase. No deterioration of water quality due to dying algal blooms occurs. As a consequence of the shorter detention period, algae growth was less intensive in 1968.

A second observation, which appears to be associated with the short detention time, is the virtually complete absence of blue-green algae, which are most troublesome in many water supply reservoirs.

Storage had a very favorable effect on different water quality characteristics. First the restoration of the dissolved oxygen content must be mentioned. Reaeration contributed to the oxygenation, as did photosynthesis.

The incidentally occurring increase in dissolved organic matter can be considered as the only less favorable consequence of phytoplankton growth in the Berenplaat reservoir, although the overall effect of storage on $KMnO_4$ consumption was definitely favorable.

Secondary effects of the algal growth were the utilization of large amounts of silica and phosphate. From quantitative considerations the conclusion can be drawn, that as time permits, silica rather than phosphate will act as a limiting factor.

Nitrification caused a reduction in ammonia content, although part of the removal may be due to algal uptake or to pH-influenced losses to the atmosphere. Nitrate presumably contributed to the dissimilation of settled organic material in the reservoir, as sometimes considerable losses in nitrate-N were recorded.

The striking reduction in threshold taste value is considered as the most important aspect of the storage of Rhine water. To meet future demands in the Netherlands, many new reservoirs storing Rhine water must be built. The conclusion seems justified that extensive baffling of these reservoirs, in order to achieve efficient taste improvement, is not necessary.

Rosen, H.M.

Use of Ozone and Oxygen in Advanced Wastewater Treatment.

JWPCF. 45(12):2521-2536. December 1973.

Key Words: bacteria, ozonation.

Abstract:

Designing an ozonation treatment plant even when considering only tertiary municipal treatment requires a thorough knowledge of the individual situation to develop a least cost system. In many future plants, oxygen will be used for enriched oxygen aeration in the activated sludge process, for aerobic sludge digestion, and for enriched oxygen incineration. A system design to minimize oxygen-ozone applications cost will be even more complex.

The many advantages of ozone in the treatment of difficult industrial wastes, such as phenols and cyanides, have not been mentioned. The problems in the treatment of industrial wastewater produce a new set of design criteria often related to water recycle. Ozone and oxygen are excellent in this respect because oxygen is the only residual left by both gases.

Advanced technology for economical oxygen and ozone generation is now available. Some systems for its application have been developed and demonstrated. However, only the surface has been scratched in the development of applications technology, not only in the municipal area but in industrial water pollution control.

Rossie, W.L., Jr.

Control of Water Quality in Transmission and Distribution Systems.

JAWWA. 67 (8):425-427. August 1975.

Key Words: bacteria, drinking and recreational water.

Abstract:

A system is a living functional unit subject to stresses. An understanding of these stresses and their interrelationships will provide a better understanding of their effects so as to resist or neutralize such stresses. Internal adjustments are necessary for a healthy distribution system.

Quality in design and construction and protective measures depend on quality materials and personnel. Adequate protective measures in the distribution system are of utmost importance for stabilized operation and quality water. Problems can be expected to increase as a result of growing population and industry, fixed water supply, and the reuse factor, which is due for greater and greater consideration.

In today's world, water can be a great benefit to man and his environment, or it can be a vehicle by which disease organisms or toxic chemicals can be widely distributed. Health and water-utility professionals must work together to ensure proper distribution, use, and protective reaction capability.

Stresses will always exist in varying degrees. Water-utilities must train dedicated, competent men to react to stress situations. Utility personnel must be aware of existing problems and must be able to recognize potential problems. Quality water provides family health protection and good consumer relations. The challenge of the future will be to continue to provide high-quality water.

Routh, J.D.

DDT Residues in Salinas River Sediments.

Bulletin of Environmental Contamination and Toxicology.
7(2/3):168-176. February/March 1972.

Key Words: DDT, surface water (fresh).

Abstract:

The chlorinated hydrocarbon, p,p' DDT is the most common DDT derivative in bottom sediment samples taken at sites in the Salinas River from the Soledad to the Highway No. 1 river crossing. Its concentration as well as the concentration of total derivatives varies from site to site along the river as well as over time. This is probably due to certain areas acting as natural depositories for water translocated suspended fine particulate matter containing high concentrations of DDT. If the rate of water flow is sufficiently low and if other unspecified natural factors are right, the particles settle and collect at sites along the river yielding a high concentration of DDT residues. Evidence which supports this hypothesis is that the areas with the finest sediment are the areas which also have the highest concentration of DDT derivatives. The portion of the Salinas River south of the Davis river crossing shows the highest concentration of the areas studied.

Rozelle, R.B. and H.A. Swain, Jr.

Removal of Manganese from Mine Drainage by Ozone and Chlorine.

Wilkes College, Wilkes-Barre, Pennsylvania, March 1975. 57p. (Available from National Technical Information Service (NTIS) as PB-241 143).

Key Words: manganese, chlorination, ozonation.

Abstract:

This research was directed toward an examination of methods by which coal mine water could be treated for removal of manganese. In order to remove manganese from mine water, strong oxidizers must be employed to oxidize it to the (+4) oxidation state in which it is relatively insoluble and will precipitate as MnO_2. Both ozone and hypochlorite ion were effective in this oxidation and reduced manganese concentrations to less than 2 mg/l and in some cases to less than 0.05 mg/l. Reaction orders based on initial reaction rates are reported for the manganese (II) at pH values of 2,4, 6 and 7.9 in the time intervals studied. Solubilities of both manganese (II) hydroxide and manganese (IV) oxide were measured. Cost data were developed for both the ozone and sodium hypochlorite treatment.

Rubenstein, S.H., J. Fenters, H. Orbach, N. Shuber, J. Reed, and E. Molloy.

Viruses in Metropolitan Waters: Concentration by Polyelectrolytes, Freeze Concentration, and Ultrafiltration.

JAWWA. 65(3):200-202. March 1973.

Key Words: viruses, ECHO virus, polio virus, coliforms, fecal streptococci, surface water (fresh), influent characteristics, effluent characteristics, filtration.

Abstract:

The recovery and concentration of viruses by either insoluble IMA or freeze concentration-ultrafiltration has been shown to be both practical, simple, and efficient. In both cases large volumes of water can be processed with a minimum of laboratory manipulation and with a high degree of certainty of viral recovery.

The inability to recover enterovirus from Lake Michigan samples is taken as indicative of the absence of these agents at detectable levels during the survey period. This finding is consistent with the fact that the city of Chicago does not discharge either raw or treated wastes into Lake Michigan.

The Chicago River yielded one viral isolate during the study period. Although the water quality of this source is known to be degraded, it appears that viral inputs are minimal at this time. Other investigators have obtained a considerable number of viral isolates using IMA concentration. However, the viruses were isolated from either sewage or from streams receiving effluents of sewage-treatment plants.

Rubin, A.J. and G.P. Hanna.

Coagulation of Bacterium *Escherichia Coli* by Aluminum Nitrate.

Environmental Science and Technology. 2(5):358-362. May 1968.

Key Words: *Escherichia coli*, chemical treatment.

Abstract:

As with other sols, the coagulation of *Escherichia coli* is strongly dependent upon the pH and applied concentration of hydrolyzing coagulant. These organisms obey the Schulze-Hardy rule for coagulation by univalent and divalent neutral salts, and presumably a polymeric species such as $Al_3(OH)_{20}^{4+}$. They are slowly coagulated by hydrogen ion at concentrations considerably below that of other univalent cations. The entire log aluminum nitrate concentration pH domain of stability for the coagulation of this strain of *E. coli* at a single concentration of the organisms was determined as indicated by settling rates.

The stability domain is very similar to those described for silver halide sols except for the boundary at pH 5.65 and the region of restabilization at low pH. Three regions of different settling rates were observed. The rate of settling in the rapid coagulation zone was greater than in the slow zone but considerably lower than in the sweep zone. Coagulation in the rapid zone is best explained by assuming the predominate aluminum species to have an octameric or similar structure and to be four-plus charged.

The sweep zone of aluminum hydroxide precipitation and rapid settling for *E. coli* was completely defined and occurs in similar concentration and pH ranges previously described for clays. The data support the contention that the dispersed particles are being enmeshed and carried down by precipitating gelatinous aluminum hydroxide (aluminum "floc"). Of course, physicochemical forces of attraction between the sol and the precipate may be important. Algae were also observed to attract floc particles to themselves.

Some workers have found that the nature of the dispersed phase has little if any effect on coagulation. Because of the similarity of the results for *E. coli* with silver halide sols in the rapid coagulation zone and clays in the sweep zone, it appears that this view is essentially correct with certain limitation. Certainly, restabilization will depend both upon the nature and concentration

of the dispersed phase. Coagulation by hydrogen ion also appears to be dependent upon the nature of the sol, and may be dependent upon its concentration.

Rudolfs, W., L.L. Folk, and R.A. Rogotzkie.

Contamination of Vegetables Grown in Polluted Soil. Part I: Bacterial Contamination.

Sewage and Industrial Wastes. 23:253-268. 1951.

Key Words: coliforms, salmonella, shigella, protozoa, *Escherichia coli*, crops, groundwater, direct contact.

Abstract:

Field experiments during two growing seasons were designed to evaluate and compare the extent of coliform contamination of tomatoes in a similar but uncontaminated environment. The pollution consisted of either furrow irrigation with settled sewage normally used for the purpose, or direct application of feces suspensions to the fruit and leaves, which may represent spray types of irrigation or direct applications of nightsoil as frequently practiced. In addition, the survival of pathogenic types, such as salmonella and shigella species, was investigated to supplement with direct evidence the findings with coliform organisms.

The results show that if sewage irrigation or nightsoil application is stopped one month before harvest, the fruit, if eaten raw, would not be likely vectors for the transmission of human bacterial enteric diseases.

Rudolfs, W., L.L. Folk, and R.A. Rogotzkie.

Contamination of Vegetables Grown in Polluted Soil, Part II: Field and Laboratory Studies on Endamoeba Cysts.

Sewage and Industrial Wastes. 23:478-485. 1951.

Key Words: protozoa, crops, groundwater.

Abstract:

Laboratory and field experiments on the survival of Endamoeba histolytica cysts applied either in suspension or in conjunction with feces to tomatoes and leaf lettuce direct, or to soil in which the plants were growing, show that the cysts are extremely sensitive to desiccation. Addition of organic matter in the form of fecal suspensions does not enhance survival of the cysts. Crops growing in the field may become contaminated directly during the course of irrigation with sewage polluted water or night soil, or indirectly through contact with polluted soil. Contaminated tomatoes and lettuce are free from viable cysts within 3 days after contamination occurs, the time of decontamination decreasing with a decrease in the degree of wetness of the soil. Field-grown crops consumed raw and subject to contamination with cysts of E. histolytica are considered safe in the temperate zone one week after contamination has stopped and after two weeks in wetter tropical regions.

Rudolfs, W., L.L. Folk, and R.A. Rogotzkie.

Contamination of Vegetables Grown in Polluted Soil. Part III: Field Studies on Ascaris Eggs.

Sewage and Industrial Wastes. 23:656-660. 1951.

Key Words: crops, groundwater.

Abstract:

Field experiments on the survival of *Ascaris suum* eggs were conducted by spraying suspensions of Ascaris eggs and feces on growing tomatoes and lettuce. Plants and fruit were harvested at intervals. Results show that a reduction of the number of eggs took place with time, but some eggs remained on the plants and fruits for more than a month. Development of eggs was greatly retarded and completely developed eggs containing motile embryos required for infection were not recovered. The exposure of undeveloped eggs to field conditions reduced greatly the viability of the eggs. It appears that resistance of Ascaris eggs on vegetable surfaces is less than might be expected from considerations of their resistance in soil, feces, or night soil. All eggs degenerated after 27 to 35 days and were incapable of development for infection.

Rudolfs, W., L.L. Folk, and R.A. Rogotzkie.

Contamination of Vegetables Grown in Polluted Soil. Part IV: Bacterial Decontamination.

Sewage and Industrial Wastes. 23:739-751. 1951.

Key Words: coliform, biological contaminants, disinfection.

Abstract:

Studies on coliform decontamination of raw tomatoes grown on sewage polluted soils, or sprayed with *E. coli* or feces, show that the natural death rate of these bacteria under ordinary storage conditions is slow and does not insure adequate decontamination. Vigorous washing for 15 min. with plain water removes most of the sprayed-on contaminants, but does not remove coliforms from tomatoes grown on polluted soil. In general, vigorous washing with anionic, nonionic, and cationic detergents is not materially better than washing with plain water. Chlorine and its compounds in high concentration in solution do not remove organisms protected by dirt, or in cracks, crevices, or bruises. Chlorine gas is a good decontaminating agent, but causes bleaching in the concentrations required. Nitrogen trichloride and t-butyl hypochlorite are not effective in the concentrations normally used for fruit spoilage control. The most effective method for consistently obtaining a low coliform residual, without affecting the appearance and condition of the vegetables, is soaking them in water at a temperature of 60°C. for 5 min.

Rudolfs, W., L.L. Folk, and R.A. Rogotzkie.

Contamination of Vegetables Grown in Polluted Soil. Part V: Helminthic Decontamination.

Sewage and Industrial Wastes. 23:853-860. 1951.

Key Words: parasitic worms, chlorination, disinfection, crops, groundwater.

Abstract:
Physical and chemical means of decontaminating vegetable surfaces contaminated by *Ascaris suum* eggs included vigorous washing and soaking in plain water, detergent solutions, germicidal rinses, and use of warm water. The results show that the eggs adhere tenaciously to solid surfaces. Various detergents and germicidal rinses were not effective killing agents, but cationic detergents will cause more than 90 percent removal of eggs from smooth surfaces, such as tomatoes. The removal is less effective when cracks, crevices, or bruises protect the eggs. The only effective method to insure vegetable decontamination with respect to helminth eggs is immersion of the vegetable in warm water (55° to 60°C.) for 10 min. Such immersion does not alter the appearance or character of the vegetables tested.

Rudolfs, W., L.L. Folk, and R.A. Rogotzkie.

Contamination of Vegetables Grown in Polluted Soil. Part VI: Application of Results.

Sewage and Industrial Wastes. 23:992-1000. 1951.

Key Words: *Escherichia coli*, salmonella, shigella, protozoa, parasitic worms, crops, groundwater.

Abstract:

This article describes original work in determining the time of viability of pathogen organisms on food crops and methods of their removal for safe human consumption.

Ryan, J.A. and D.R. Keeney.

Ammonia Volatilization from Surface-Applied Wastewater Sludge.

JWPCF. 47(2):386-393. February 1975.

Key Words: ammonia, anaerobic digestion, land reclamation.

Abstract:

When the wastewater sludge is surface-applied to soil, anywhere from 11 to 60 percent of the applied NH_4-N can be lost by NH_3 volatilization, depending on the soil used and the rate of sludge addition. Losses decreased as the clay content of the soil increased, while higher rates of addition resulted in greater losses. Larger losses were also observed by repeated application of wastewater sludge.

Ryther, J.H.

Preliminary Results with a Pilot-Plant Waste Recycling-Marine Aquaculture System.

Woods Hole Oceanographic Institute, Woods Hole, Massachusetts, July 1975. 40p.

Key Word: nitrates, ponding/land application.

Abstract:

Complete nitrogen removal may be accomplished by growing unicellular marine algae in continuous, flow-through cultures in effluent-seawater mixtures. Shallow (1 meter), 2,500 ft^2, PVC-lined ponds, gently circulated to maintain the algae in suspension, have been used for this purpose. Optimal and maximum possible size of ponds to achieve the same or an improved performance have not been determined.

Salmonella Surveillance.

U.S. Center for Disease Control, HEW. Report No. 122. February 1975.

Key Words: salmonella, epidemiology.

Abstract:

In the second quarter of 1974, 5,110 isolations of salmonellae were reported from humans, an average of 393 isolations per week; this article is a summary of salmonella surveillance.

Salmonella Surveillance Annual Summary 1974.

U.S. Center for Disease Control, HEW. Report No. 125. August 1975.

Key Words, salmonella, epidemiology.

Abstract:

In 1974, 23,838 isolations of salmonella were reported to CDC, a decrease of 2,855 cases (10.7%) from the previous year. As in 1973, *Salmonella typhimurium* (including *S. typhimurium* var. *copenhagen*), *S. newport*, and *S. enteritidis* were the first, second, and third most commonly isolated serotypes, respectively.

Salmonella Surveillance Annual Summary 1974.

U.S. Center for Disease Control, HEW. Report No. 126.
September 1976.

Key Words: salmonella, epidemiology.

Abstract:

This report summarizes information received from state and city health departments, university and hospital laboratories, U.S.F.D.A., and other sources, domestic and foreign about isolations of salmonella in 1975.

Salotto, B., V.E. Grossman III, and J.B. Farrell.

Elemental Analysis of Wastewater Sludges from 33 Wastewater Treatment Plants in the United States.

In Pretreatment and Ultimate Disposal of Wastewater Solids. A. Freiberger, ed. EPA-902/9-74-002, Environmental Protection Agency, Region II, New York, 1974. pp. 23-72.

Key Words: chromium, phosphates, nitrates, copper, nickel, zinc, boron, cadmium, cobalt, mercury, manganese, lead, anaerobic digestion.

Abstract:

Sludges, principally of the digested type, from 33 municipal wastewater treatment plants in the United States have been analyzed for 21 metals, nitrogen, phosphorus, and sulphur. The BTU value of some sludges was also determined. Atomic absorption method was used for the determination of metals in sludge. No detectable amount of beryllium was found in any sludge sample analyzed and although very toxic, it evidently does not present a commonly encountered hazard in the disposal of sludge.

Mathematical analysis of the data indicated that the distribution of heavy metals in sludge is approximately log-normal. This behavior is characteristic of all sludge types analyzed thus far. Levels of metals in essentially domestic sludges were found to correspond closely to the 25th percentile distribution of metals in all sludges reported. Comparison of the levels of metals in the United States sludges with corresponding levels in Scandinavian sludges show higher levels in the U.S. sludges. Variation of any particular metal in sludges of a particular wastewater treatment plant was much less than in sludge samples taken from different plants.

Saltzman, S., L. Kliger, and B. Yaron.

Adsorption-Desorption of Parathion as Affected by Soil Organic Matter.

Journal of Agriculture and Food Chemistry. 20:1224-1226.
June 1972.

Key Words: organophosphorous pesticides, surface water (fresh), surface water (marine).

Abstract:

Influence of soil organic matter on the adsorption-desorption of parathion was studied by using tagged insecticide. It was found that the parathion adsorption by soils is dependent on the type of association between the organic and mineral colloids. In aqueous solutions the parathion has a greater affinity for organic than for mineral adsorptive surfaces. Parathion bonding is stronger on organic than on mineral surfaces.

Sanborn, J.R.

The Fate of Select Pesticides in the Aquatic Environment.

University of Illinois, Urbana, December 1974. 93p. (Available from National Technical Information Service (NTIS) as PB-239 749).

Key Words: pesticides, dieldrin, chlorinated hydrocarbons,
herbicides, surface water (fresh), fish.

Abstract:

This article gives concentration data of different pesticides throughout the aquatic environment.

Sanders, H.O. and J.H. Chandler.

Biological Magnification of a Polychlorinated Biphenyl (Aroclor 1254) from Water by Aquatic Invertebrates.

Bulletin of Environmental Contamination and Toxicology. 7(5):257-263. May 1972.

Key Words: DDT, chlorinated hydrocarbons, fish.

Abstract:

Biological accumulation of Aroclor 1254 is very rapid (reaching 25 x 10^3 in 4 days) in aquatic invertebrates.

Sartor, J.D., G.B. Boyd, and F.J. Agardy.

Water Pollution Aspects of Street Surface Contaminants.

JWPCF. 46(3):458-467. March 1974.

Key Words: BOD, COD, phosphates, nitrates, ammonia, zinc, copper, lead, mercury, chromium, DDT, DDD, aldrin, coliforms, combined municipal and/or storm systems.

Abstract:

The major constituent of street surface contaminants was consistently found to be inorganic, mineral-like matter, similar to common sand and silt. Significant amounts of heavy metals were detected in the contaminant materials collected from street surfaces. Zinc and lead were the most prevelant.

Savage, H.P. and N.B. Hanes.

Toxicity of Seawater to Coliform Bacteria.

JWPCF. 43(5):854-861. May 1971.

Key Words: coliforms, surface water (marine).

Abstract:

Under the conditions studied, it was concluded that:

1. With somewhere between 1 and 10 mg/l initial BOD, fresh seawater temporarily loses its toxicity to total and fecal coliform bacteria.

2. In fresh seawater with BOD levels of 10 to 120 mg/l, the relationship between the log of the maximum bacterial densities and the initial BOD seemed to be linear.

3. The percentage of both fecal and total coliform bacteria contributing to the total population increased as maximum density was approached and decreased as the populations declined.

4. By themselves, total and fecal coliform bacteria are not reliable indicators of the degree of recent fecal pollution in seawater because, given sufficient nutrient levels, the bacterial density will increase.

Sawyer, C.N. and P.A. Hahn.

Temperature Requirements for Odor Destruction in Sludge Incineration.

JWPCF. 32(12):1274-1278. December 1960.

Key Words: bacteria, air, incineration.

Abstract:

The temperature required for odor destruction varies somewhat with the character of the sludge processed and the method of concentration or conditioning. Sludges concentrated by anaerobic flotation did not have unusual temperature requirements. The vapors from only a few sludges were adequately deodorized at 1,250°F. Most required a temperature of 1,300 or 1,350°F and a few required 1,400°F.

The intensity of odors was appreciable at 50°F below the threshold level and severe at 100°F below.

Temperatures required for destruction of odors from volatile fatty acids varied from 1,370 to 1,425°F.

Odor-free incinerator operation requires that strict attention be given to control of temperatures in the deodorizing zone and that a factor of safety be employed commensurate with atmospheric conditions and other local factors.

Sayler, G.S., J.D. Nelson, Jr., A.Justice, and R.R. Colwell.

Distribution and Significance of Fecal Indicator Organisms in the Upper Chesapeake Bay.

Applied Microbiology. 30(4):625-638. October 1975.

Key Words: fecal streptococci, bacteria, coliforms, surface water (fresh), surface water (marine).

Abstract:

Total viable aerobic heterotrophic bacteria, total coliforms, fecal coliforms, and fecal streptococci were enumerated in samples collected at five stations located in the Upper Chesapeake Bay, December 1973 through December 1974. Significant levels of pollution indicator organisms were detected at all of the stations sampled. Highest counts were observed in samples collected at the confluence of the Susquehanna River and the Chesapeake Bay. The indicator organisms examined were observed to be quantitatively distributed independently of temperature and salinity. Counts were not found to be correlated with concentration of suspended sediment. However, significant proportions of both the total viable bacteria (53%) and fecal indicator organisms (>80%) were directly associated with suspended sediments. Correlation coefficients (r) for the indicator organisms examined in this study ranged from r = 0.80 to r = 0.99 for bottom water and suspended sediment, respectively. Prolonged survival of fecal streptococci in most of the sediment samples was observed, with concomitant reduction of the correlation coefficient from r = 0.99, fecal streptococci to total coliforms in water, to r = 0.01, fecal streptococci to fecal coliforms in sediments. The results of this study compared favorably with fecal coliforms:fecal streptococci ratios for the various sample types. Characterization of organisms beyond the confirmed most-probable-number procedure provided good correlation between bacterial indicator groups.

Saz, A.K., S. Watson, S.R. Brown, and D.L. Lowery.

Antimicrobial Activity of Marine Waters. I: Macromolecular Nature of Antistaphylococcal Factor.

Limnology and Oceanography. 8(1):63-67. January 1963.

Key Words: Staphylococcus aureus, surface water (marine).

Abstract:
Water from Vineyard Sound, Mass., has a rapid bactericidal activity against both penicillin-sensitive and -resistant strains of Staphylococcus aureus but under the conditions of these experiments, exhibits no anti-coliform effect. It has been demonstrated that the active factor is a large, non-dialyzable, autoclave-labile molecule. The preponderance of gram-negative bacteria in the sea is discussed in light of the above findings.

Scarpino, P.V.

Human Enteric Viruses and Bacteriophages as Indicators of Sewage Pollution.

To be presented at International Symposium on Discharge of Sewage from Sea Outfalls, London, August 28, 1974. 11p.

Key Words: viruses, epidemiology.

Abstract:

This is a general article on microbial indicators as well as human enteric viruses and bacteriophages as indicators of sewage pollution.

Scarpino, P.V. and D. Pramer.

Evaluation of Factors Affecting the Survival of *Escherichia coli* in Sea Water.

Applied Microbiology. 10(5):436-440. September 1962.

Key Words: *Escherichia coli*, surface water (marine).

Abstract:

The relationship between death of cells of *Escherichia coli* in artificial sea water and time was established as linear, and statistical tests demonstrated that the most suitable measure of survival was log percent after 24 hr. Survival of *E. coli* in water supplemented with cysteine at levels of 0.284×10^{-6} to 284×10^{-6} M was increased greatly over that in untreated water. To provide an insight into the mode of action of cysteine, the effect of concentration of various sulfhydryl and disulfide compounds was measured, and the influence of several compounds that lack a functional sulfur group but which are capable of affecting oxidation-reduction potential was determined. Moreover, a number of substances related structurally to cysteine were tested to ascertain their influence on the survival of cells of *E. coli* in artificial sea water. It appeared that the beneficial effect of cysteine was not due to the sulfhydryl group of the amino acid or to the ability of the compound to influence oxidation-reduction potential. Some sulfhydryl compounds had no favorable effect and, in general, disulfides were more active than the corresponding sulfhydryl compounds. Substances that lack a functional sulfur group but influence oxidation-reduction potential had no significant activity. The beneficial effect of a number of compounds related structurally to cysteine indicates that both an amino and carboxyl group are required for activity. It is suggested that cysteine and other amino acids act to increase survival of cells of *E. coli* in sea water by a chelation mechanism.

Scarpino, P.V., M. Lucas, D.R. Dahling, G. Berg, and S.L.Chang.

Effectiveness of Hypochlorous Acid and Hypochlorite Ion in Destruction of Viruses and Bacteria.

In: Chemistry of Water Supply, Treatment and Distribution. A.J. Rubin, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1975, pp. 359-368.

Key Words: *Escherichia coli*, polio virus, coxsackie virus, chlorination.

Abstract:

There are still many questions in disinfection of water yet unanswered. Good comparative disinfection data are required from which guidelines can be drawn for providing safe waters free from pathogens. Present microbiological standards for water quality need to be reassessed to include standards for animal viruses of enteric origin, since animal viruses can be more resistant to chlorination than the coliforms that form the backbone of the present safety standards for water. Additional research is required comparing the relative survival times, number, and seasonal presence of coliphages in the water environment with those of animal viruses of pathogenic significance to man. The data, however, does cast doubt upon the ultimate merit of coliphage indicator models of enteric virus presence, in regard to survival characteristics, since the coliphages studied were not as resistant as the viruses of man to comparable environmental circumstances.

Schafer, H.A.

Characteristics of Municipal Wastewater Discharges,1975.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1976. pp. 57-60.

Key Words: ammonia, BOD, cyanides, oil and grease, phosphates, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, elemental contaminants, DDT, chlorinated hydrocarbons, surface water (marine).

Abstract:

This paper includes tabular listings of 1) concentrations of general constituents, metal, and chlorinated hydrocarbons in five southern California municipal effluents in 1975; 2) mass emissions of and from the same, 1975; and 3) combined annual mass emission rates, 1971-1975.

Several trends were noted: 1) 1971-74, in general, constituents decreased slightly; 2) 1971-74, DDT decreased by a factor of 10; 3) 1971-74, PCB's and metals stayed constant; 4) 1974-75, suspended solids increased by 10%; 5) 1974-75, all metals except silver declined; and 6) 1974-75, PCB declined.

Schafer, H.A. and W. Bascom.

Sludge in Santa Monica Bay.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1976. pp. 77-82.

Key Words: cadmium, chromium, copper, lead, mercury, nickel, surface water (marine).

Abstract:

This is a discussion of the results of marine sediment analyses around the City of Los Angeles (Hyperion plant) sludge outfall. No attempts are made to draw conclusions; the report is simply a series of observations and analytical results.

Schaub, S.A., C.A. Sorber, and G.W. Taylor.

The Association of Enteric Viruses with Natural Turbidity in the Aquatic Environment.

In: Virus Survival in Water and Wastewater Systems. J.F. Malina, Jr. and B.P. Sagik, eds. University of Texas at Austin, Center for Research in Water Resources, 1974. pp. 71-83.

Key Words: polio virus, viruses, surface water (fresh).

Abstract:

It is very possible that in nature, viruses in water and wastewater will adsorb virus only to a degree dictated by the physical-chemical make-up of the water. Adsorbed virus will remain in the water phase only until the solids reach a point where they settle to the bottom as deposits are removed during flocculation or filtration. As a natural water runs its course to the sea, greater adsorption may occur as additional solids, increased cation, lower pH, or other alterations occur. Alternatively, dilution, organics, or higher pH may provide less adsorption. Virus associated with bottom sediments may be resuspended by increased stream velocity or by the seasonal turnover of a lake or reservoir.

Viruses in water, whether existing as free entities or adsorbed to solids, must be considered together as infectious entities. The results of this infectivity study demonstrate that solids-associated virus lose little infectivity in lab animals when compared to similar suspending media without solids. Therefore, caution is necessary when equating virus removal in treatment systems with inactivation. New methods of virus detection and concentration should be capable of assaying solids adsorbed virus.

Schaub, S.A., E.P. Meier, J.P. Kolmer, and C.A. Sorber.

Land Application of Wastewater: The Fate of Viruses, Bacteria, and Heavy Metals at a Rapid Infiltration Site.

United States Army Medical Research and Development Command, Washington D.C., May 1975. 57p. (Available from National Technical Information Service (NTIS) as AD-A011 263).

Key Words: viruses, bacteria, fecal streptococci, total organic carbon, lead, iron, copper, chromium, ponding/land application, groundwater.

Abstract:

1. Laboratory studies indicate that enterovirus and f2 tracer virus are not readily adsorbed to the upper portions of the soil profiles studied when saturated with wastewater.

2. The f2 bacteriophage is not significantly impeded in the soil strata and can readily penetrate to the groundwater.

3. Fecal indicator bacteria are concentrated on the rapid infiltration cell soil surface but significant numbers are capable of migration into the groundwater.

4. Vertical movement of f2 bacteriophage and fecal *Streptococcus* paralleled the movement of percolating wastewater into the building groundwater mound beneath the RI cells.

5. Horizontal movement of the groundwater is toward the Nashua River. Enterovirus, f2 bacteriophage tracer and fecal *Streptococcus* move with the groundwater and were detected sporadically but in substantial numbers at monitoring points up to 600 feet away.

6. The subsurface "black layer" observed in unrenovated cells has a high total organic carbon and heavy metal content.

7. The "black layer" disappears from the subsurface soils several months after sewage application is discontinued.

8. Renovated beds have high total organic carbon and heavy metal accumulation on the soil surface only.

9. A renovated cell with a declining infiltration rate was observed to be accumulating total organic carbon and heavy metals in subsurface layers in excess of that observed in other similarly renovated cells.

10. To accurately assess the movement of microorganisms and other pollutants from a land wastewater disposal site, it is important to realize that frequent samples or composites

may be necessary to observe "spike" concentrations.

11. Because the groundwater intercepts the polluted Nashua River, there is little direct health hazard from study site.

Scheier, A. and P. Kiry.

The Delaware Estuary System, Environmental Impacts and Socio-Economic Effects. A Discussion of the Effects of Certain Potential Toxicants on Fish and Shellfish in the Upper Delaware Estuary.

Rutgers-The State University, New Brunswick, New Jersey, Water Resources Research Institute, December 1973. 59p. (Available from National Technical Information Service (NTIS) as PB-231 423).

Key Words: surface water (fresh), shellfish.

Abstract:

The purpose of this paper is to set forth the potential toxicants in the Upper Delaware Estuary and whether their concentrations are sufficient to contribute to the reduction of fish and shellfish species in the Upper Estuary. A list of species historically found in the Upper Delaware Estuary serves as a baseline for comparison with species lists recently compiled during surveys of the upper estuary. A summary of the maximum concentrations of metals found in the Upper Estuary is presented, along with their recommended safe concentrations.

Schistosomiasis Control: Report of a WHO Expert Committee.

World Health Organization, Geneva, Switzerland. July 3-7, 1972. 47p.

Key Word: epidemiology.

Abstract:

The Committee concluded that there is now clear evidence that transmission of schistosomes in human populations can be markedly reduced by the use of currently available methods, and that in countries where rapid economic progress has been accompanied by antischistosomal programs the disease has steadily decreased. More long-term reports on control projects must be awaited and there is still room for improvement in the quality of evaluation of projects.

The Committee also observed that schistosomiasis continues to increase where new irrigation schemes and man-made lakes are being developed. Such increases can be partly avoided if suitable action is taken at the planning stage, and steps are also taken to allocate a regular budget for preventive action.

The Committee considered that the desirable plan of a schistosomiasis control program is now fairly clear. After collecting and analysing baseline data for both planning and evaluation, a clear objective should be formulated and funds obtained on a long-term basis. In the case of a pilot project, unmodified comparison areas should also be studied and data collected in order to determine changes in incidence, prevalence, and intensity of infection that may result from control activity. Costs of pilot projects should be analysed and economic and medical benefits assessed where possible.

Schistosomiasis programs have sometimes been avoided because they have been considered too costly. However, the costs and availability of labour and epidemiological circumstances that may occur in endemic foci vary so much that it is not possible to state the probable costs of a control program. Existing control programs have been estimated to have annual recurrent costs with a range of U.S. $0.40-12.00 per caput. This means that very poor countries with widespread endemic schistosomiasis may be unable to attempt generalized control of transmission. However, the Committee considered that schistosomiasis control is within the capability of some countries that do not have such programs and it believed that some degree of effective schistosomiasis control is financially feasible in all commercial irrigation developments.

Schmid, L.A. and R.E. McKinney.

Phosphate Removal by a Lime-Biological Treatment Scheme.

JWPCF. 41(7):1259-1276. July 1969.

Key Words: phosphates, activated sludge, chemical treatment.

Abstract:

1. Both the orthophosphates and the polyphosphates normally present in wastewater can be precipitated readily with lime.

2. The phosphates present in wastewater, in particular the complex phosphates, seriously inhibit the precipitation of calcium carbonate, even when the soluble phosphate concentration is reduced to less than one mg/l.

3. Since very little calcium carbonate will be precipitated at the normal operating pH, lime regeneration from the sludge mixture will not be practical.

4. The addition of 150 mg/l of calcium hydroxide ($Ca(OH)_3$) resulted generally in a pH of 9.5, total phosphorus removals of 80 percent, BOD removals of 60 percent, and SS removals of 90 percent. Lower alkalinity wastewaters will require lower lime dosages for equal removals.

5. The sludge produced from the primary unit with lime treatment can be expected to be about twice that obtained by conventional settling. When the sludge quantities are compared for the overall system, including the waste activated sludge, the lime system results in a total sludge production less than 1.5 times the conventional production.

6. Satisfactory control of the process can be obtained by operating at a constant pH after jar tests and experience have determined the desired pH.

7. Operation of a complete mixing activated sludge system following lime treatment is not hindered providing proper control is exercised.

8. Microbial production of carbon dioxide in the activated sludge unit is sufficient to maintain a pH near neutral in the aeration compartment.

9. The mixture of lime precipitated primary sludge and waste activated sludge will dewater and filter well with relatively small additions of anionic polymers.

10. This chemical-biological system of phosphate removal is capable of removing 90 to 95 percent of the total phosphorus from a domestic wastewater containing 40 to 50 mg/l as total phosphate with lime dosages generally less than 150 mg/l as calcium hydroxide.

11. The total net cost of removing 90 percent or more of the phosphates from a domestic wastewater, including both capital and operating costs, is estimated to be approximately $2.50/mil gal (3,785 cu m) for a 10-mgd (37,850-cu m/day) plant.

Schmidt, C.J. and E.V. Clements, III.

Reuse of Municipal Wastewater for Groundwater Recharge.

Municipal Environmental Research Laboratory, Cincinnati, Ohio, September 1977. 154p. (Available from National Technical Information Service (NTIS) as PB-272 620).

Key Words: pesticides, activated sludge, trickling filters, BOD, COD, adsorption/ion exchange, phosphates, heavy metals.

Abstract:

This report provides a comprehensive summary and evaluation of current efforts throughout the U.S. to recharge groundwater systems with treated municipal wastewater. Through these recharge programs, groundwater supplies are being replenished, saltwater endangered aquifers are being protected, and water is being reclaimed for future reuse.

Schmidt, C.J., I. Kugelman, and E.V. Clements III.

Municipal Wastewater Reuse in the U.S.

JWPCF. 47(9):2229-2245. September 1975.

Key Words: BOD, suspended solids, total dissolved solids, aluminum, arsenic, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, phosphates, coliforms, ammonia, nitrates, crops, effluent characteristics, drinking and recreational water, chemical treatment, chlorination.

Abstract:

The primary purpose of this study was to make a state-of-the-art survey that would summarize information about existing reuse of wastewater from municipal plants with emphasis on direct reuse of the water as it leaves the treatment plant. The basic approach involved a comprehensive literature search and a questionnaire which was sent to 153 domestic and 55 foreign wastewater reuse sites. The data was tabulated, organized and analyzed. This paper is a summary of the study's major findings.

Schmidt, N.J., J.L. Melnick, H.A. Wenner, H.H. Ho, and M.A. Burkhardt.

Evaluation of Enterovirus Immune Horse Serum Pools for Identification of Virus Field Strains.

Bulletin of the World Health Organization. 45:317-330. 1971.

Key Words: viruses, polio virus, coxsackie virus, epidemiology.

Abstract:

Immune horse sera to 42 enterovirus immunotypes were pooled according to the Lim Benyesh-Melnick and the "intersecting serum" schemes. Each serum was diluted in the pools to contain 50 antibody units. After it was established that the pools correctly neutralized prototype virus strains, they were evaluated in tests against 273 enterovirus field strains representing most of the viral types included in the pools. With test virus doses of 10-100 TCD_{50}, most of the poliovirus and coxsackie virus field strains were correctly identified in both schemes, but a number of the echoviruses were neutralized by heterotypic pools, particularly in the Lim Benyesh-Melnick scheme. However, at higher test virus doses of 320-3200 TCD_{50}, little heterotypic neutralization occurred in either scheme, and 93-94% of the virus field strains were correctly identified in each scheme. With these larger virus doses, breakthrough tended to occur in homologous pools by the 7th day, but rarely by the 5th day. Since the Lim Benyesh-Melnick pool scheme employs 8 pools as compared with 13 for the intersecting serum scheme, and since the two schemes were equally satisfactory for identifying virus field strains at test virus doses of 320-3200 TCD_{50}, immune horse sera will be pooled by the former scheme, thus utilizing fewer pools, for distribution to qualified viral diagnostic laboratories.

Schnare, D.W.

EPA Standards: Health or Headache?

JAWWA. 67(9):507-509. September 1975.

Key Words: drinking and recreational water.

Abstract:

Solutions to problems must be considered on all levels. EPA may be unwilling, or indeed unable, to compromise with its set plans. If state governments intend to maintain a dominant role in water-pollution control, and if local governments do not want to be stampeded into giant new appropriations for drinking-water-treatment facilities, each must exert itself in productive ways. One opportunity the EPA strategy suggests is regionalization.

Although regionalization of water supplies would be in many cases too expensive and too time consuming, regionalization of laboratory services could be essential to compliance with the standards. Funding could be provided under the federal program, and one facility serving three to six states could draw upon much larger resources. Besides meeting the presently unanswered needs, diminution of overhead and a more standardized analysis would be the primary results.

With or without a satisfactory solution to the fiscal externalities, the public education activity cannot be ignored. When the consumer wants to know what is in the water, the local supplier must have an answer. When the public wants to know the health significance of contaminants that might be in the water, the local supplier should be ready to provide the relevant literature. If the supplier does not have such materials, the state and the EPA should provide it upon demand. Through the program objectives, EPA intends "To provide technical assistance on a continuing basis to state agencies, (and) local utilities." This assistance can be interpreted to include relations with the consumer. This resource should be rapidly exploited by both the states and the local suppliers before the public goes on the offense.

The goal is safe drinking water, but this must be a goal realized through activities that actually succeed in improving the quality of the U.S.'s drinking water. An addition of public education to the EPA's high-priority activities and a review of their funding policy and monitoring requirements could provide the useful tools that will ensure safe drinking water to all.

Schroeder, H.A. and J.J. Balassa.

Abnormal Trace Metals in Man: Arsenic.

Journal of Chronic Diseases. 19:85-106. 1965.

Key Words: arsenic, epidemiology.

Abstract:

A survey of arsenic in the biosphere, involving analyses of substances by which man is exposed, has been made, using ashing at low temperatures and chemical methods. Arsenic was found in soils, most foods, many waters, almost all plants and plant products tested and in most animal tissues. Arsenic is ubiquitous in the biosphere, with a few special exceptions.

Two forms of arsenic exist in the environment of man, pentavalent and trivalent. The biological activities of arsenic in these valence states differ markedly. Pentavalent arsenic as arsenate is nontoxic in normal concentrations, is excreted rapidly, largely through the kidneys, probably does not accumulate in human tissues, is a normal constituent of food and may perform some unknown physiological function. It is not inhibitory to most enzymes and can substitute for phosphate in some phosphorylases. The daily intake of human beings is in the range of 400-1000μg. The requirement of rats and mice for arsenic, if any, is less than 0.26μg 100 g body weight per day.

Trivalent arsenic as arsenite is the principal form produced commercially. It is toxic, chelating with dithiol groups and inhibiting those enzymes dependent thereon. It accumulates in the mammalian body, especially in the integument where it combines with keratin disulfides, is excreted largely from intestine, is a contaminant of soils and foods through its use in herbicides and pesticides and performs no known physiological function. Trivalent inorganic arsenic is slowly oxidized to the pentavalent form in the upper layers of the earth's crust and in the mammalian body.

The biological activities of the two valence states of arsenic must not be confused. The extensive literature on arsenic is replete with confusion.

Sea foods and a few other foods and waters consumed by man often exceed the allowable limit of arsenic concentration imposed by government agencies of the United States and Great Britain, attempting to limit residues of arsenites.

There is no evidence that natural arsenate causes any diseases of man. Furthermore, definitive evidence that inorganic arsenites are a cause of experimental or human cancer is lacking, although both acute and chronic toxicity is well known. The bad reputation of arsenic as a poison is due to the toxicity of the commercial trivalent form and is undeserved in the case of the natural pentavalent form. A simple method for distinguishing these two forms of arsenic is needed.

Schuetzle, D., D. Cronn, and A.L. Crittenden.

Molecular Composition of Secondary Aerosol and Its Possible Origin.

Environmental Science and Technology. 9(9):838-845.
September 1975.

Key Words: synthetic/organics, air.

Abstract:

Several aerosol samples were collected during a diurnal period of inversion and aerosol production in Pasadena, California. Particles were collected in two size ranges: particles of diameters less than 1-2μ m and particles of diameters greater than 1-2μ m. Computer-controlled mass spectrometric thermal analysis was used for molecular organic and inorganic analysis. The results described in this paper are semiquantitative with a precision of ±30% on a relative comparison basis, but accuracies may range up to two times for some of the organic secondary aerosols with estimated response factors. X-ray fluorescence and atomic absorption were used to obtain inorganic elemental composition. The diurnal variation in aerosol composition was studied for the two size ranges and used to postulate the primary and/or secondary origin of the aerosol. The most probable precursors for the measured secondary aerosol products are presented in this paper and postulated from the results of smog chamber studies and the gaseous composition of gasoline, auto exhaust, and ambient air samples. The primary pollutants included alkanes, polycyclic aromatics, substituted phenols, and several elements. Organic secondary pollutants included acids, aldehydes, alcohols, chlorides, and nitrates. Inorganic secondary pollutants identified included sulfates, nitrates, and chlorides. The results are discussed with respect to meteorological conditions.

Schulze, J.A., D.B. Manigold, and F.L. Andrews.

Pesticides in Selected Western Streams - 1968-71.

Pesticides Monitoring Journal. 7:73-84. June 1973.

Key Words: DDT, chlorinated hydrocarbons, herbicides,
surface water (fresh).

Abstract:

Compounds determined include the common chlorinated insecticides and herbicides. Heptachlor and its epoxide were not detected during the 3-year period, and aldrin was found only once. DDT was the most frequently occurring insecticide, and 2,4,5-T the most common herbicide. The amounts observed were small; the maximum concentration of an insecticide was 0.46 μg/liter for DDT, and of an herbicide 0.99 μg/liter for 2,4-D. Concentrations were highest in water samples, containing appreciable amounts of suspended sediments. Graphs are included in this article to show insecticide and herbicide occurrences for the 4-year period (October 1967-September 1971) during which all 20 monitoring stations have been in operation.

Beginning in July 1970, the phosphorothioate insecticides - parathion, methyl parathion, malathion, and diazinon - were determined monthly on all samples. Malathion was not found during this period. Polychlorinated biphenyl (PCB's) compounds which were monitored for beginning in October 1969 were also detected at two stations.

Schwartz, H.G., Jr.

Adsorption of Selected Pesticides on Activated Carbon and Mineral Surfaces.

Environmental Science and Technology. 1(4):332-337. April 1967.

Key Words: chlorinated hydrocarbons, herbicides, adsorption/ion exchange.

Abstract:

Powdered activated carbon readily adsorbs CIPC from aqueous solutions. In the well stirred experimental systems, approximately 24 hours were required to reach equilibrium. Of the total equilibrium adsorption achieved in 24 hours, about 90% was attained in 4 hours. The adsorption equilibrium of the activated carbon-CIPC aqueous system can be represented closely by a Freundlich isotherm. For the Freundlich expression, $x/m = kC^{1/n}$, constants n and k were calculated to be 9.1 and 0.20, respectively. The ultimate capacity of the activated carbon for CIPC is estimated to be about 0.34 mg of CIPC per mg of carbon.

The adsorption of CIPC on activated carbon is independent of the hydrogen ion concentration over the pH range from 4.8 to 9.3. With an estimated acidity constant of about 10^{-5}, CIPC would exist predominantly in the molecular form over most of the experimental pH range.

The adsorption of CIPC on activated carbon appears to involve physical or weak chemical bonding. The heat of adsorption is estimated to be = 7.0 kcal per mole. Adsorption processes involving electrostatic or weak chemical bonds typically have heats of adsorption of the same order of magnitude. Furthermore, the adsorption of CIPC is reversible. Such reversibility is an additional indication of physical or weak chemical bonding. The structure of CIPC would seem to be well suited for hydrogen bonding between the amino group and carbonyl oxygen atoms on the activated carbon surface.

Initial rates of adsorption for the CIPC-activated carbon system vary directly with the square root of time. This relationship is characteristic of many diffusion-controlled sorption processes. The nominal activation energy is estimated to be about 3.4 kcal per mole, a value indicative of diffusion-controlled processes.

Schwarz, J.R. and R.R. Colwell.

Effect of Hydrostatic Pressure on Growth and Viability of _Vibrio parahaemolyticus_.

Applied Microbiology. _28_(6):977-981. December 1974.

Key Words: bacteria, surface water (marine).

Abstract:

Six strains of marine bacteria, including three strains of _Vibrio parahaemolyticus_, two Vibrio species isolated from coastal regions, and the deep ocean isolate _Pseudomonas bathycetes_, were examined for ability to survive and grow at deep ocean hydrostatic pressures. _V. parahaemolyticus_ and the coastal Vibrio species were unable to survive or grow at 200, 400, 600, 800, or 1,000 atm of pressure. In contrast, the deep ocean isolate _P. bathycetes_ was capable of survival and growth at these pressures. The evidence strongly supports the neritic or estuarine origin and habitat for _V. parahaemolyticus_.

Schwarz, J.R. and R.R. Colwell.

Heterotrophic Activity of Deep-Sea Sediment Bacteria.

Applied Microbiology. 30(4):639-649. October 1975.

Key Words: bacteria, surface water (marine).

Abstract:

Sediment samples, containing mixed microbial populations that were decompressed during retrieval from 7,750 and 8,130 m in the Puerto Rican Trench, were recompressed and incubated at the approximate in situ temperature (3 C) and pressure (775 or 815 atm) in the presence of ^{14}C-labeled amino acids. Heterotrophic activity (total uptake, CO_2 respiration, and cellular assimilation) and cellular-associated "pool" concentrations were measured. Compared with atmospheric controls held at 3C, the total uptake at elevated pressure at 3 C was reduced, on an average, 55 times, CO_2 respiration was reduced 45 times, and cellular assimilation was reduced 69 times. Rate of total uptake at elevated pressure was found to range from 4.0×10^{-11} µg/cell per h for leucine to 2.61×10^{-10} µg/cell per h for an amino acid mixture. Also, the percentage of total uptake at elevated pressures, respired as CO_2, increased at the expense of cellular assimilation (ca. 22% increase). Two cellular-associated amino acid pools were detected, a large, loosely bound, outer pool and a small, tightly bound internal pool. The loosely bound outer pool was removed by a change in the pH of the incubation medium. Even though heterotrophic uptake and the outer, cellular-associated pool were markedly reduced at an elevated pressure, the percentage of total uptake calculated for the unincorporated, tightly bound, intracellular pool was 2 to 19 times that obtained for cultures held at 1 atm. The results were interpreted as indicating that bacterial metabolism and biosynthesis in the deep sea are markedly reduced, with a greater proportion of metabolic activity devoted to cellular maintenance.

Schwarz, J.R., J.D. Walker, and R.R. Colwell.

Deep-Sea Bacteria: Growth and Utilization of Hydrocarbons at Ambient and in situ Pressure.

Applied Microbiology. 28(6):982-986. December 1974.

Key Words: bacteria, surface water (marine).

Abstract:

Microorganisms present in Atlantic Ocean sediment samples collected at a depth of 4,940 m were found to be capable of utilizing hydrocarbons under both ambient and in situ pressures. The rate of utilization under in situ pressure (500 atm) and ambient temperature (20°C) was found to be significantly less compared with hydrocarbon utilization examined under conditions of ambient temperature (20°C) and pressure (1 atm).

Schwarz, J.R., J.D. Walker, and R.R. Colwell.

Deep-Sea Bacteria: Growth and Utilization of N-hexadecane at in situ Temperature and Pressure.

Canadian Journal of Microbiology. 21(5):682-687. 1975.

Key Words: bacteria, surface water (marine).

Abstract:

This article discusses microbial activity at deep sea level as well as growth and utilization of N-hexadecane at in situ temperature and pressure.

Schwarz, J.R., J.D. Walker, and R.R. Colwell.

Growth of Deep-Sea Bacteria on Hydrocarbons at Ambient and in situ Pressure.

Developments in Industrial Microbiology. 15:239-249. 1973.

Key Words: bacteria, surface water (marine).

Abstract:

Thirty four strains of bacteria were isolated from the mud-water interface of core samples collected 150 miles east of Cape Kennedy, Florida, at a depth of 4940 meters. The strains were isolated using a medium containing n-tetradecane as the sole carbon source. A mixed culture of seven of the original isolates was transferred three times in n-tetradecane medium. The mixed culture was found to utilize n-tetradecane, with virtually all the available hydrocarbon being degraded after 7 days' growth at 1 atmosphere. Disappearance of the hydrocarbon in the medium was monitored by gas-liquid chromatography. At 495 atmospheres and 25 C, the mixed culture degraded 96% of the n-tetradecane initially present after 28 days at the elevated hydrostatic pressure. The individual isolates form the mixed culture did not utilize n-tetradecane as pure cultures, indicating a potential synergistic relationship. Characterization of the strains using selected taxonomic procedures yielded tentative identification and classification of the strains as Aeromonas, Pseudomonas, and Vibrio species.

Schwinn, D.E. and B.H. Dickson, Jr.

Nitrogen and Phosphorus Variations in Domestic Wastewater.

JWPCF. 44(11):2054-2065. November 1972.

Key Words: ammonia, BOD, suspended solids, nitrates, nitrites.

Abstract:

The concentrations of ammonia, total nitrogen, and phosphorus in several raw domestic wastewaters have been measured. The means and the standard deviations of the concentrations, the linear regression coefficients between them, the seasonal and daily variations, and the magnitudes of peak occurrences of various durations have been studied. The data obtained lead to the following conclusions:

1. For purposes of design, the ammonia, total nitrogen, and phosphorus concentrations can be assumed to be independent of the flow and of BOD and SS concentrations.

2. The BOD and SS concentrations are inversely related to flow and positively correlated to each other, but the most extreme BOD and SS concentrations generally do not occur simultaneously.

3. There were no pronounced seasonal variations or differences between the days of the week in the data from the plants studied.

Scott, D.S. and H. Horlings.

Removal of Phosphates and Metals from Sewage Sludges.

Environmental Science and Technology. 9(9):849-855. September 1975.

Key Words: phosphates, aluminum, iron, zinc, anaerobic digestion.

Abstract:

When phosphate removal is practiced in a treatment plant, nearly all the metals and phosphate regardless of source appear in the final sludge. Concentrations may be high enough to affect the use or disposal of the sludge.

Metals and phosphates can be easily removed from anaerobically produced sludges by extraction with dilute acid. Either thickener underflow or dewatered filter cake is a satisfactory sludge source. Some variations in degree of extraction will occur in metals - e.g., iron or copper, that can be in more than one valence state, and depending on the acid used for extraction.

The extract solution after filtering can be fractionated by selective precipitation over the pH range of 2.5-7.5 into solids, each containing a majority of some of the metallic cations. These products are mixed phosphates and hydroxides of the metals. The residual liquor contains most of the water-soluble organics and is free of most heavy metal cations and of phosphates.

The crude metal-phosphate solid products can be further treated by conventional means to recover phosphate or specific metallic components. Based on amounts in the influent streams or added as treating chemicals, these crude solids will contain 80-90% of the iron, aluminum, zinc, and phosphate. The fractional recovery of other heavy metals depends on the nature of the original sludge.

Scott, M.L.

Trace Elements in Animal Nutrition.

In: Micronutrients in Agriculture. R.C. Dinauer, ed. Soil Science Society of America, Madison, Wisconsin, 1972. pp. 555-591.

Key Words: manganese, zinc, iron, copper, molybdenum, iodides, groundwater, crops.

Abstract:

Of the entire periodic table only eight inorganic trace elements have been unequivocably proven to be essential in animal nutrition. These are Mg^{2+}, Mn^{2+}, Zn^{2+}, Fe^{2+}, Cu^{2+}, I^-, Mo^{6+1}, and Sc^{4+}. All except I^- and Sc^{4+} have been shown to be required as activators of enzymes. Iodine is essential for formation of the hormone thyroxine. Iron is important in the vital, metabolically-active chelates, in hemoglobin, in myoglobin, and in the cytochromes. Some of the polyvalent cations are important in amino acid transport. Selenium is involved in one or more unknown roles essential to normal health and life. In most instances a deficiency of even one of these trace elements results in severe deficiency symptoms and death. One exception is Mo, which has been shown to be an integral part of the enzyme, xanthine oxidase, but thus far it has not been demonstrated to produce deficiency symptoms or death in an animal, without resorting to the use of tungstate as an antagonist of Mo metabolism in the animal.

In the category of trace elements that have been shown to have various influences upon growth, upon metabolism, or upon development of some particular tissue, there are five other elements that may prove to be of considerable importance in nutrition. These are F, Cr, Ni, Sn, and V. Fluoride has been shown to improve the texture of bone, and particularly, of teeth. It appears possible that the compound fluoroapatite may be essential for maximum quality of bone and tooth structure.

One researcher has written an excellent review of the present situation regarding Cr in nutrition. Chromium has been shown to be the glucose tolerance factor. Thus, Cr^{3+} enhances the effects of insulin in converting excess blood glucose into fat in rats. He has presented results of several workers indicating the possibility that Cr^{3+} may be of importance in helping to control blood sugar levels in humans, especially in some old people and in some diabetics.

Another researcher has shown that chicks reared in plastic cages and given highly purified diets required Ni for

maximum growth and prevention of an unusual leg deformity. Sn was reported to be an essential element for growth in rats, and the growth-promoting effects of V in rats in a trace element-controlled environment was also reported. V deficiency may affect plasma cholesterol levels of chicks.

Many other elements (i.e., Al, Si, etc.) are known to be present in rather constant amounts in animal tissues. Some of these elements have been shown to be activators of several different enzymes in vitro. However, thus far none of these elements has been demonstrated to be nutritionally essential.

Much of the work on activation of enzyme systems by trace elements has been conducted with isolated, in vitro biochemical systems. Studies are needed to determine the specificity of many of these elements in specific enzyme reactions, and to determine the extent to which other elements may spare the nutritionally essential ones, and the degree to which certain elements may competitively inhibit the activating effects of the essential inorganic elements. Much further work is needed to determine the extent to which in vitro findings apply in intact, living animals.

The role of polyvalent cations in amino acid transport is a fertile field for further investigation. The role of amino acids and other ligands in the formation of chelates, both for absorption and for the transport of essential nutrients, should lead to improved diets for better health of animals, including man.

Sekikawa, Y., S. Nishikawa, M. Akazaki, and K. Kato.

Release of Soluble Ortho-Phosphate in the Activated Sludge Process.

Advances in Water Research. 1966(2):261-284.

Key Words: phosphates, activated sludge.

Abstract:

The experiments show that activated sludge releases orthophosphate under the unfavorable conditions as (a) deficiency of nutrients, (b) lack of dissolved oxygen, and (c) admixture of poisonous substances.

Release of phosphates is dependent on the operating conditions and biological character of the sludge used in the experiment. The results obtained seem to suggest that phosphate variation might serve as an appropriate index to a change of sludge character. Subsequently, measurement of phosphate variation will play an important role for the purpose of checking practical performance of an activated sludge plant.

However, to make it more positive, a series of successive studies should be performed under more complicated operational conditions.

Selleck, R.E., L.W. Bracewell, and R. Carter.

The Significance and Control of Wastewater Floatables in Coastal Waters.

University of California at Berkeley, Sanitary Engineering Research Laboratory, January 1974. 128p.

Key Words: oil and grease, coliforms, chlorinated hydrocarbons, surface water (marine).

Abstract:

Significance of flotage derived from submerged primary effluent plumes in the Southern California Bight is evaluated in terms of three components: Particulates> or = 0.5 mm in size, particulates< or = 0.1 mm in size, and surface film materials. The sampling methods utilized to collect the flotage from the surface are described in detail. The surface film and micro-particulates were captured by fabric screen samplers developed during the course of the study. It was found that the large particulates penetrated the ocean thermocline and gathered on the surface in profusion. The grease and wax portions of the particulates could be measured reliably with hexane extraction, with the mass of HEM of sewage origin being in the order of a metric ton on the water surface within the study area. Such particulates contained considerable numbers of coliform bacteria but little PCB compounds or pesticides.

Sepp, E.

Disposal of Domestic Wastewater by Hillside Sprays.

Journal of the Environmental Engineering Division, ASCE. 99:(EE2):109-121. April 1973.

Key Words: ponding/land application.

Abstract:

Spray irrigation of hillsides is a reliable method of land disposal of domestic wastewater in areas where the soils are not suitable for subsurface disposal and the terrain does not permit the construction of large ponds. Hillside spray systems are most suitable for the disposal of seasonal flows and on soils with good infiltration capacity. Success depends largely on proper design and operation of the system, including provisions for adequate reliability features for the prevention of runoff and measures to protect the public from the spray. The use of alternate disposal facilities may be necessary during wet weather, freezing, and snow-melt periods.

Renovation of the effluent by the soil mantle is possible if designed for this purpose. If nutrient removal is an objective of the system, the land must be cropped to prevent recycling of the nutrients.

Sepp, E.

Nitrogen Cycle in Ground Water.

Bureau of Sanitary Engineering, State of California, Sacramento, 1970. 23 p.

Key Words: ammonia, nitrates, nitrites, air, groundwater.

Abstract:

1. The sources of nitrogen compounds in soil and groundwater are numerous and diverse. The compounds undergo complex transformations caused by environmental factors.

2. Atmospheric precipitation adds from 0.7 to 14 pounds of nitrogen per acre to the soil annually. Nitrogen fixing organisms in the soil may add from a few pounds to 200 pounds per acre of nitrogen per year.

3. Depending on circumstances, either agricultural practice or land disposal of sewage may be the major contributor of nitrogen to groundwater. Normal irrigation practice can supply sufficient water to establish a continuous film water contact between the soil surface and groundwater table, whereby the nitrates from the topsoil may be leached into the groundwater.

4. Ammonia and ammonium ion are held close to soil surface by adsorption and cation-exchange reactions. Nitrate and nitrite ions, however, move freely with the percolating water.

5. In the presence of sufficient amounts of free oxygen, nitrogen compounds present in sewage or most organic matter become rapidly oxidized to nitrate by bacteria. The formation of nitrate is also dependent on temperature, pH, moisture, number of bacteria, and a favorable carbon to nitrogen ratio. Some aspects of nitrification are not clearly understood.

6. Under anaerobic conditions, nitrate may be reduced to nitrogen gas by the action of facultative denitrifying bacteria which can use nitrate and nitrite as sources of oxygen.

7. Nitrogen may be removed from soil by cropping, leaching, erosion or volatilization. Gaseous losses may occur as ammonia at high pH and high temperature, and as nitrogen gas in acid or flooded soils.

8. Nitrogen compounds can be removed from domestic water by the ion exchange process; however, it is at present too expensive for large-scale use.

9. The use of high-nitrate water can be avoided by the following procedures:

(a) blending high-nitrate water with low-nitrate waters,
(b) using selected aquifers, and
(c) exclusion of high-nitrate water by proper well construction and sealing.

10. Nitrogen may be removed from wastewater at varying efficiencies by algae ponds, ion exchange, ammonia stripping, microbial denitrification, and electrodialysis.

11. In recharge of domestic water aquifers with sewage effluent the total oxygen demand, which measures the oxygen utilized both by carbonaceous and nitrogenous materials, is an important factor to be considered. In surface spreading of effluent almost all the nitrogen is rapidly oxidized to nitrate in the spreading bed and percolates downward. In direct injection of effluent, microbial denitrification in the anaerobic zone around the recharge well may remove some of the nitrate, and ammonia may also be partly removed by adsorption.

12. At present, not enough is known to establish design criteria for controlling nitrate reduction in the aquifer. Therefore, proponents of groundwater recharge with sewage effluent should include considerations for reducing the nitrogen content of sewage by treatment.

Sepp, E.

The Use of Sewage for Irrigation: A Literature Review.

Bureau of Sanitary Engineering, State of California,
Sacramento, 1971. 41p.

Key Words: coliforms, mycobacterium, salmonella, shigella, protozoa, bacteria, parasitic worms, crops, groundwater.

Abstract:

There is an increasing interest in the reuse of treated sewage for landscape irrigation and other higher uses, and sewage itself is called reclaimed water. However, crop irrigation still accounts for the greatest portion of reuse and the health hazards still remain the same regardless of the name.

This revision of a report first published in 1963 was prompted by exhaustion of the previous edition, availability of new information, increasing demand for the information, and the growing interest in water reclamation.

Seppalainen, A.M. and I. Häkkinen.

Electrophysiological Findings in Diphenyl Poisoning.

Journal of Neurology, Neurosurgery, and Psychiatry. 38(3):248-252. 1975.

Key Word: epidemiology, synthetic/organics.

Abstract:

The fungistatic agent diphenyl (biphenyl) caused fatal poisoning with signs of neurotoxicity in a worker in a Finnish paper mill. This initiated a neurophysiological study of 24 workers (1 woman and 23 men) occupationally exposed to diphenyl. Ten men showed EEG abnormalities which, while non-specific, were compatible with generalized cerebral disturbance. The abnormalities persisted on re-examination 1 and 2 yr later. Nine subjects had EMG abnormalities; 7 also exhibited fibrillations in some muscles. One subject showed a long rhythmic series of fasciculations similar to the spontaneous activity described in infantile spinal muscular atrophy. Nerve conduction velocity, especially that of slower motor fibers, was reduced in several cases. Electroneuromyographic abnormalities also persisted on re-examination. Although diphenyl is considered a comparatively safe chemical, it showed evidence of neurotoxicity when workers were exposed to concentrations in excess of the presently accepted threshold limit of 1 mg/m^3. The average concentration measured in the air at various work places varied from 0.6 to 123.0 mg/m^3. Electrophysiological methods should be applied for the early detection of occupational hazards.

Sewage Sludge Burned Without Smoke or Odor.

Public Works. 102:72-74. October 1971.

Key Word: incineration.

Abstract:

Sludge incineration will input S to the atmosphere in the form of SO_2 along with hydrocarbons.

Sguros, P.L.

Microbial Degradation of Cyclodiene Pesticides.

Florida Atlantic University, Boca Raton, Department of Biological Sciences, January 1974. 106p. (Available from National Technical Information Service (NTIS) as AD-778 763).

Key Words: dieldrin, aldrin, chlorinated hydrocarbons, arsenated hydrocarbons, surface water (fresh), surface water (marine).

Abstract:

Decomposition of the pesticides aldrin and dieldrin by aquatic micro-organisms may result in more harmful products affecting the ecosystem. Isolates from fresh, brackish, and littoral water were cultured using, variously, selective media, enriched laboratory ecosystems, and impregnated wood strips and assessed qualitatively and quantitatively for action on pesticides by thin-layer chromatography, gas-liquid chromatography, and 14C-labeled pesticide autoradiography. Growth was measured in terms of dry wt and cell nitrogen. Small amounts of possible metabolites were indicated in most isolate preparations. Cellulolytic Z xylestrix grew well in media containing 10-500 ug/ml pesticide. Growth was stimulated by small quantities of the chemical and the fungus accumulated pesticides to levels 2000 times higher than the original medium concentration. Uptake increased linearly with increasing pesticide concentration. A significant portion of the pesticides appeared to be chemically altered, but the products were not specifically identified.

Shane, M.S., W.S. Vincent, R.E. Cannon, and H.A. Glass.

Effect of Pollution on Distribution of LPP Phycoviruses in Relation to Pollution of the Christina River.

University of Delaware, Newark, Department of Biological Sciences, August 1974. 22p. (Available from National Technical Information Service (NTIS) as PB-238 034).

Key Words: viruses, surface water (fresh).

Abstract:

The primary objective of the study was to screen the environment for the presence of LPP cyanophages, and evaluate their presence with respect to the level of pollution. Field studies demonstrated that pollution increases the hosts susceptibility to viral infection. Several isolates were found to be temperate phages, and the existence of lysogeny was demonstrated in the laboratory. Further studies indicated that a soil amoeba, *Hartmanella glebae*, played a role in the ecology of LPP-1. From this work, a probable model was postulated for control of *Plectonema boryanum* populations in the environment.

Shane, M.S., R.E. Cannon, and E. DeMichele.

Pollution Effects on Phycovirus and Host Algae Ecology.

JWPCF. 44(12):2294-2302. December 1972.

Key Words: ammonia, nitrates, nitrites, viruses, surface water (marine).

Abstract:

The chemical and physical parameters defining the lower reaches of the Christina River describe a river that is unable to cope with the existing organic loading. Declining DO values were the most prominent symptom. Although organic concentrations were low, ammonia, nitrate, and nitrite levels generally increased markedly at Stations 6 through 11 to levels that indicate the presence of untreated wastewater. High zinc concentrations might have caused some inhibiting effects on the bacterial population at Stations 8 through 11. However, the varying MPN and the unknown frequency and range of heavy metal loadings preclude drawing conclusions without additional data.

While the upper reaches of the Christina River seemed to be free of detectable viruses, lysed cultures of the alga Plectonema boryanum were noted for Stations 5 through 11, thus indicating the presence of LPP virus. This shows that the LPP viruses are definitely associated with an increase in cultural pollution and may be one more important pollution parameter.

During this study every sample was investigated microscopically to find and identify the host algae. Attempts to cultivate the host algae were fruitless. Other investigators have experienced this same difficulty, and one speculates that other organisms also may serve as reservoirs of the virus.

Shane, M.S., S.B. Wilson, and C.R. Fries.

Virus-Host System for Use in the Study of Virus Removal.

JAWWA. 75(9):1184-1186. September 1967.

Key Words: viruses, filtration, surface water (fresh).

Abstract:

Much information concerning virus removal in water and sewage treatment processes can be gained by using this virus-host system as a tool.

No definite conclusions can be drawn concerning virus removal based on the limited number of runs at this time, but the information gained confirms other reported information concerning virus removal. Coagulation and settling did not remove as many virus particles as previously reported. This system may have value for making comparison studies using coagulant aids, such as long-chain polymers, and to gain other information concerning virus studies in water and sewage treatment. The technique is simple and inexpensive. High bacterial counts do not interfere with plaque enumeration, and bacteria which are heterotrophic will not grow on the synthetic inorganic medium used to cultivate the algae for assay of the virus. This would not be true if animal cell tissue culture was used.

Shellfish Study of San Francisco Bay, April-June 1972.

U. S. Environmental Protection Agency, San Francisco, California, Surveillance and Analysis Division, June 1974. 57p. (Available from National Technical Information Service (NTIS) as PB-240 394).

Key Words: salmonella, lead, cadmium, chlorinated hydrocarbons, shellfish.

Abstract:

From April to June 1972, a study was undertaken by the Environmental Protection Agency, Region IX, to determine whether or not selected San Francisco Bay shellfish beds were contaminated and to determine whether or not significant changes had occurred in the density and size of shellfish populations from 1967 to 1972. The beds surveyed were those with commercial potential (as assessed by Wooster, 1968) and with dimensions greater than 10,000 square feet.

Laboratory analyses were conducted to determine the existing health hazards as well as aesthetic quality of the shellfish beds. Determinations were made to test the presence of selected heavy metals (lead, mercury, cadmium, copper, chromium, zinc); pesticides, polychlorinated biphenyls (PCB's); and bacteria of sanitary significance (total and fecal coliforms, salmonella). Results from San Francisco Bay sampling stations were compared with data obtained from analyses of commercial oysters grown at Drake's Estero.

Shelton, R.G.J.

Sludge Dumping in the Thames Estuary.

Marine Pollution Bulletin. 2(2):24-27. February 1971.

Key Words: zinc, copper, lead, surface water (marine).

Abstract:

Until more of the fauna samples have been examined and further analyses of the sediments made, it is not possible to do more than discuss the ecological state of the outer Thames Estuary in very general terms. Nevertheless, it is quite apparent that there is a great contrast between the condition of the outer Thames dumping grounds and those off New York. The large areas of completely anaerobic sediments with an overlying layer of water of low oxygen content which have been reported to occur off New York have not, so far, been found during the present survey.

The benthos of the Barrow and Black Deeps, while showing some effects of sludge disposal, is nevertheless surprisingly normal for an estuary with strong tidal currents. It appears that the relatively high concentration of organic matter in the sediments is associated with an increase in the numbers and diversity of the polychaete fauna, and it is interesting that this effect is most marked in the Black Deep, where dumping has occurred over a long period but where it has not been done for the last three years. The large numbers of tomato seeds found in this Deep also suggest that sludge, if it behaves in a similar way, may persist in the sediments long after dumping has stopped. To what extent sludge dumping causes death of marine animals due to local deoxygenation immediately after dumping is as yet unclear. The finding of dead material in the Black Deep suggests that such an effect might be significant, but many more observations would be required to confirm, and if possible quantify, this effect, if indeed it is present.

More work is also required to assess the effects on the benthos of the industrial components of the sludge, which may tend to reduce the fertilizing effects of the fine organic solids. Preliminary analyses of the sediments show that zinc, lead and copper, which are present in the solids of the sludge, are also present, at peak wet-weight concentrations of 85, 125 and 100 mg/kg respectively, in the organic mud of the Black and Barrow Deeps and Sea Reach. In general, the levels are a little higher in Sea Reach, where the organic content of the sediments is also high, than in either of the two Deeps. Further work is

necessary both to confirm these values on a dry-weight basis and to estimate the chlorinated hydrocarbon levels present in the sediments and benthos. Another question, as yet unanswered, is that of the fate of the fine organic matter which is the principal solid component of the sludge. It is possible that the main settlement of this material is some way from the dumping areas where the heavier particles such as tomato seeds and other large debris settle out. Possibly the large accumulation of organic matter in the sediments of Sea Reach is due, at least in part, to sludge dumping in the Barrow and Black Deeps. Further study is necessary, however, using tracer techniques, to establish this point.

Shelton, S.P. and W.A. Drewry.

Tests of Coagulants for the Reduction of Viruses, Turbidity, and Chemical Oxygen Demand.

JAWWA. 65(10):627-635. October 1973.

Key Words: biological contaminants, COD, chemical treatment, chlorination.

Abstract:

This study attempts to ascertain (1) how effective different chemical coagulants and polyelectrolytes are in virus removal; and (2) how well results using the same primary coagulants, correlate for relatively unpolluted raw surface water, a moderately polluted surface water, and a secondary wastewater treatment-plant effluent with respect to virus removals.

Shen, Y.S.

Study of Arsenic Removal from Drinking Water.

JAWWA. 65(8):543-548. August 1973.

Key Words: arsenic, adsorption/ion exchange, filtration.

Abstract:

Three methods for the removal of arsenic compounds were compared in this article: adsorption, ion exchange, and filtration.

Sherman, J.C., T.A. Nevin, and J.A. Lasater.

Hydrogen Sulfide Production from Ethion by Bacteria in Lagoonal Sediments.

Bulletin of Environmental Contamination and Toxicology.
12:359-365. March 1974.

Key Words: organophosphorus pesticides, surface water (fresh).

Abstract:
Ethion is readily degraded in the aquatic environment. In this study, only 50% of the original Ethion was still present after a three week period. One of the by-products is toxic H_2S.

Sherwood, M.J. and A.J. Mearns.

Disease Responses in Southern California Coastal Fishes.

Southern California Coastal Water Research Project.
El Segundo, Ca. December 1974.

Key Word: fish , surface water (marine).

Abstract:

The nearshore demersal fish communities of southern California have been extensively monitored by public and private agencies since 1969. The Southern California Coastal Water Research Project has assembled and analyzed much of the data in order to evaluate the health of local populations. One approach has been to investigate the frequency of diseased or anomalous specimens. Diseases with external symptoms may be easily observed and quantified in the field, and the presence of diseased individuals in a given habitat may be indicative not only of the health of the population but also of an imbalance in the community.

A number of disease conditions were recorded during the trawl surveys. Of these, only fin erosion in the Dover sole (*Microstomus pacificus*) appeared to be directly related to wastewater discharge sites. At present, there are no direct links between the identifiable field effect and the suspected causes. A laboratory program has been designed to determine the role of microorganisms and physical/chemical factors in the disease response.

Shigella Surveillance.

U.S. Center for Disease Control, HEW. Report No. 37, March 1976.

Key Words: shigella, epidemiology.

Abstract:

Shigella isolations from 10,193 humans were reported for the period July through December 1974.

Shigella Surveillance Annual Summary.

U.S. Center for Disease Control, HEW. Report No. 38.
September 1976.

Key Words: shigella, epidemiology.

Abstract:

This report summarizes data voluntarily reported from participating states, territorial, and city health departments about shigella isolations from humans.

Shimizu, Y.

Further Studies of the Interaction of Chlorine and Organic Molecules in Water.

Office of Water Research and Technology, Department of the Interior, Washington, D.C., 1975. 13p.

Key Words: synthetic/organics, chlorination.

Abstract:

Some of the possible chemical reactions between chlorine and organic molecules such as amino acids, phenolic compounds, nucleic acids, and lignin in aqueous solution were determined. The project also studied possible reactions of certain organic compounds such as caffeine and vanillin which are present in some foods and beverages with residual chlorine in drinking water.

Shin, E. and P.A. Krenkel.

Mercury Uptake by Fish and Biomethylation Mechanisms.

JWPCF. 48(3):473-501. March 1976.

Key Words: mercury, food poisoning, fish, shellfish.

Abstract:

The objectives of these studies were (a) to examine the dynamic properties of inorganic mercury and methylmercury, (b) to determine the uptake rates of methylmercury biosynthesized in sediment by fish and the effects on the uptake rates of varying environmental conditions, and (c) to observe the effects of varying environmental parameters on the overall methylation activities of microorganisms. In addition, an estimate of the retention time of mercury in contaminated sediments was to be ascertained.

Shipp, R.F. and D.E. Baker.

Pennsylvania's Sewage Sludge Research and Extension Program.

Compost Science: 16(2):6-8. March-April 1975.

Key Words: aluminum, iron, manganese, zinc, copper, nickel, cadmium, chromium, lead, cobalt, ammonia, nitrates, nitrites, phosphates, effluent characteristics.

Abstract:

Some sewage sludges contain such high concentrations of heavy metals that they should not be used continuously and without restriction as a fertilizer supplement for crop production, because of the potential buildup of plant toxicity levels in the soil and the potential long-term threat to human and animal health, represented by food-chain incorporated contaminants. Pennsylvania had a testing and interpretive service which analyzed sewage sludge to determine suitability and appropriate application rates.

Showen, C.R. and O.O. Williams.

Index to Water-Quality Data Available from the U.S. Geological Survey in Machine-Readable Form to December 31, 1972. Central Region.

U.S. Geological Survey, Washington, D.C., June 1973. 959p. (Available from National Technical Information Service (NTIS) as PB-232 922).

Key Words: groundwater, direct contact, surface water (fresh).

Abstract:

The report lists water quality stations operated by the Geological Survey for which data are available in machine-readable form. The data are the results of analyses of water samples and indicate the chemical and physical characteristics of surface and ground water. The stations are listed according to station number within each State. The water quality data are identified by five-digit parameter codes and are grouped into twenty-one parameter categories. The analytical results for all samples in any one year are then grouped within the parameter categories. The report lists the available retrieval options, the machine-readable output options, user charges, and how to obtain the data.

Shuckrow, A.J., G.W. Dawson, and D.E. Olesen.

Treatment of Raw and Combined Sewage.

Water and Sewage Works. 118(4):104-111. April 1971.

Key Words: COD, ammonia, nitrates, nitrites, phosphates, suspended solids, influent characteristics, chemical treatment.

Abstract:

The work reported in this article represents the results of an extensive laboratory investigation of a new wastewater treatment process which was conducted with raw municipal wastewater from Richland, Washington.

The physical-chemical process developed utilized powdered activated carbon, inorganic coagulants, and polyelectrolytes and achieved highly efficient solids and organic removal while minimizing detention time and space requirements.

All the results pointed to the feasibility of meeting the desired goals of short detention time, compatibility with intermittent use and widely fluctuating flows and wastewater composition, small space requirements, high quality effluent and economical operation.

Shuval, H.I.

Detection and Control of Enteroviruses in the Water Environment.

In: Developments in Water Quality Research. Ann Arbor-Humphrey Science Publishers, Ann Arbor, Michigan, 1969. pp. 47-71.

Key Words: viruses, surface water (fresh), drinking and recreational water, chlorination.

Abstract:

This is a general article with some specific data including the enterovirus concentrations in raw sewage, drinking water, and surface water sources.

Also included are discussions on concentration and detection methods, chlorination on viruses, and standard methods of wastewater purification.

Shuval, H.I.

Health Factors in the Re-Use of Waste Water for Agricultural, Industrial, and Municipal Purposes.

In: Problems in Community Wastes Management. World Health Organization, Geneva, Switzerland, 1969. pp. 76-89.

Key Words: coliforms, viruses, synthetic/organics, herbicides, nitrates, total dissolved solids, gravity separators, groundwater, crops.

Abstract:

Waste water, after adequate treatment, can be recycled for use in agriculture and industry and, in certain circumstances, may in time become available for municipal and domestic use if a particularly high degree of treatment with adequate safeguards is provided.

In planning programs for the utilization of waste water, the public health implications must be given careful consideration, since physical, microbiological or chemical pollution may place limits on the use of reclaimed water.

Shuval, H.I. and E. Katzenelson.

The Detection of Enteric Viruses in the Water Environment.

In: Water Pollution Microbiology. R. Mitchell, ed.
Wiley, New York, 1972. pp. 347-361.

Key Words: viruses, surface water (fresh).

Abstract:

This article includes discussion of the types of viruses in water, isolation and identification of enteric viruses, and detection methods (or concentration methods), and is a general article on enteric viruses in water.

Shuval, H.I. and N. Gruener.

Health Considerations in Renovating Wastewater for Domestic Use.

Environmental Science and Technology. 7(7):600-604. July 1973.

Key Words: surface water (fresh).

Abstract:
This is a review paper that will provide a firm basis for discussions concerning reuse of water.

Shuval, H.I., S. Cymbalista, Y. Zohar, N. Goldblum, and
A.M. Wachs.

Chlorination of Wastewater for Virus Control.

Munich Abstracts - Section II. 38(3):343.

Key Words: viruses, chlorination.

Abstract:

Infectious hepatitis and poliomyelitis have been accepted as virus diseases which can be waterborne. There is strong evidence that the accepted practices of chlorination of wastewater and drinking water do not provide adequate control of enteroviruses.

A study of controlled chlorination of treated wastewater at the Haifa trickling filter plant was undertaken to determine chlorination and contact periods for effective virus control.

Shuval, H.I., S. Cymbalista, A. Wachs, Y. Zohar, and
N. Goldblum.

The Inactivation of Enteroviruses in Sewage by Chlorination.

Advances in Water Pollution Research. 1966(2):37-51.

Key Words: viruses, ECHO virus, polio virus, chlorination.

Abstract:

A study of the inactivation by chlorine of echovirus and poliovirus strains seeded in effluent from the Haifa municipal sewage treatment plant was carried out using applied chlorine doses of 3.6 to 11 mg/l with contact periods up to 6 hr. The pH ranged from 7.7 to 7.8 and the experiments were carried out at 20° ± 2°C. The results obtained were compared with the inactivation of coliform organisms under identical conditions. The following conclusions were drawn:

1. The chlorine present in the sewage was probably in the form of combined chlorine because of the high concentration of ammonia and nitrogenous organic compounds in the sewage. These complexes are known to be low in their disinfection ability compared to forms of free available chlorine. The chlorine residuals remaining after 6 hr of contact varied, but in all cases a concentration above 0.3 mg/l was present.

2. The strain of echovirus used was sensitive to the combined chlorine in the sewage with reductions of 99 percent in 30 min and 99.93 percent in 6 hr using 3.6 mg/l of chlorine. No virus was recovered in the sample tested after 4 hr with 7 mg/l of applied chlorine or after 2.5 hr with 11 mg/l of applied chlorine. The echovirus followed known inactivation patterns which were shown to be a function of time and chlorine concentration.

3. The strain of poliovirus type 1 used was much less sensitive to the combined chlorine with only 50- and 90-percent reductions in 6 hr with 5 and 11 mg/l, respectively.

4. Coliform reductions obtained followed known patterns, with a standard of less than 100 coliforms/100 ml being obtained in 80 percent of the samples after 2 hr of contact with a chlorine dose of about 8 mg/l.

5. Although the inactivation of the echovirus strain was comparable to that obtained with coliform organisms, this study indicates that the coliform index in chlorinated sewage may not give a true picture of the degree of inactivation obtained with the more resistant strains of enterovirus such as poliovirus type 1.

6. Inactivation of viruses seeded in sewage in concentrations many times greater than those normally present in sewage may not be representative of actual field situations. To carry out studies with normal wild virus concentrations, methods for detecting minimal virus concentrations as low as 1-10 P.F.U./l are required. Virus concentration techniques such as those being developed by the authors may be of value in such future studies.

Shuval, H.I., E. Katzenelson, and I. Butum.

Risk of Communicable Disease Infection Associated with Wastewater Irrigation in Agricultural Settlements.

Science. 194:944-946. November 26, 1976.

Key Words: hepatitis virus, salmonella, shigella, bacteria, gravity separators.

Abstract:

The incidence of enteric communicable diseases in 77 kibbutzim (agricultural communal settlements) practicing wastewater spray irrigation with partially treated nondisinfected oxidation pond effluent is compared with that in 130 kibbutzim practicing no form of wastewater irrigation. The incidence of shigellosis, salmonellosis, typhoid fever, and infectious hepatitis is two to four times higher in communities practicing wastewater irrigation. No significant differences are found for the incidence of streptococcal infections, tuberculosis, and laboratory-confirmed cases of influenza. Nor are differences found for enteric disease rates during the winter nonirrigation season. Strong wastewater treatment measures, including effective bacterial and viral inactivation through disinfection are recommended for all cases of sewage irrigation or land disposal near residential areas in light of the potential public health risks involved.

Sierka, R.A.

Activated Carbon Treatment and Ozonation of MUST Hospital Composite and Individual Component Wastewaters and MUST Laundry Composite Wastewaters.

Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, Maryland, March 1975. 58p. (Available from National Technical Information Service (NTIS) as AD-A008 347).

Key Words: total organic carbon, adsorption/ion exchange, ozonation, effluent characteristics.

Abstract:

The report summarizes the laboratory studies performed to evaluate the unit operations of adsorption by activated carbon and oxidation by ozone (O) for posttreatment of MUST hospital wastewaters which have been treated by ultrafiltration (UF) alone or by UF and reverse osmosis (RO). An objective of less than 5 mg/l of total organic carbon (TOC) in the final treated wastewater was considered an appropriate goal. Individual hospital waste streams and composite hospital and laundry waste streams were studied. The tests indicated that only about 33% of the residual TOC in RO-treated hospital composite wastes could be adsorbed by powdered activated carbon. The effect of pH on TOC removal by carbon was not significant in the range tested, pH 2.5 to 10.8. In contrast, about 60% of the TOC in UF-treated hospital composite wastes was adsorbable with carbon.

Silvey, J.K.G., R.L. Abshire, and W.J. Nunez III.

Bacteriology of Chlorinated and Unchlorinated Wastewater Effluents.

JWPCF. 46(9):2152-2162. September 1974.

Key Words: fecal streptococci, coliforms, surface water (fresh).

Abstract:

An extensive bacteriological and chemical study was made on a particular segment of the Trinity River in Texas. Waste effluents were shown to contribute high numbers of fecal coliforms and fecal streptococci. Chlorination was effective in reducing the quantities of microorganisms only at the station where chlorine was directly applied. Hence, no station below the entrance of the chlorinated effluent was affected. Furthermore, bacterial populations were shown to recover immediately when chlorination was terminated. Beneficial heterotrophic organisms were observed to be most susceptible to chlorine, with fecal coliforms, nonfecal coliforms, and fecal streptococci being less susceptible in this order. Chlorination was not totally effective in destroying pathogenic Salmonellae; these organisms were isolated as frequently during chlorination as during periods of nonchlorination. Effluent BOD was slightly improved as a result of chlorination, as was DO. Self-purification became somewhat evident as the river proceeded downstream because the BOD was progressively decreasing. Chlorinated hydrocarbons were detected in the river as a result of chlorination; however, their effects on the microbiota and the ecology of the river have not been determined. Chlorination, according to data obtained from this investigation, did not effectively improve pre-existing conditions of the river.

Simpson, R.E., W. Horwitz, and C.A. Roy.

Surveys of Mercury Levels in Fish and Other Foods.

Pesticides Monitoring Journal. 7:127-133. March 1974.

Key Words: mercury, livestock, fish, shellfish.

Abstract:

The Food and Drug Administration (FDA) conducted a series of surveys of the mercury content of food in 1970, 1971, and 1972. The surveys included a wide variety of fish samples from selected freshwater regions, commercial fish from wholesale distributors, and swordfish and canned tuna fish; 10 commodities representing a high proportion of total food consumption; and 12 total diet fractions collected in the FDA continuing market basket study to determine pesticide residues in the basic 2-week diet of a 19-year-old male.

For most samples analyzed, atomic absorption was used as the determinative step; the more sensitive neutron activation technique was used to confirm low levels of mercury found by the atomic absorption method.

Swordfish samples showed the highest incidence of mercury and the average mercury content, with levels in excess of 1 ppm in more than 50% of the samples examined. Approximately 4% of the canned tuna fish contained mercury in excess of the FDA guideline of 0.5 ppm for mercury in fish. Some freshwater species contained elevated levels of mercury traceable to known sources of mercury pollution. Of other commercial fish sampled, halibut, bonita, mackerel, cod, and snapper contained some elevated mercury levels, but averaged below the 0.5 ppm guideline.

In the survey of mercury in foods in which 10 food commodities were analyzed, mercury was detected only in shrimp at levels approximating 0.05 ppm. In the total diet fractions only meat, fish, and poultry contained mercury as high as 0.04 ppm. All other fractions contained mercury levels lower than the sensitivity of the method, i.e., 0.002 ppm on a dry-weight basis.

Singer, P.C.

Anaerobic Control of Phosphate by Ferrous Iron.

JWPCF. 44(4):663-669. April 1972.

Key Words: phosphates, chemical treatment.

Abstract:

Stoichiometric additions of ferrous iron can achieve efficient removal of orthophosphate from wastewater as ferrous phosphate. The solubility product of ferrous phosphate at 25°C and an ionic strength of 0.1 has been measured as $10^{-29.9}$ or 1.3×10^{-30}. Accordingly, no appreciable release of orthophosphate occurs under the reducing conditions encountered in anaerobic sludge digesters, even at treatment plants where ferric iron has been employed as a phosphate precipitant. Ferrous phosphate may also be of significance in influencing phosphate transport during seasonal transformations in limnological systems.

Singer, P.C.

Trace Metals and Metal-Organic Interactions in Natural Waters.

Ann Arbor Science Publishers, Ann Arbor, Michigan, 1974. 374p.

Key Words: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, germanium, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thorium, tin, uranium, zinc, surface water (marine), surface water (fresh).

Abstract:

This book developed from a symposium sponsored by the Division of Air, Water, and Waste Chemistry of the American Chemical Society. The papers herein represent a cross section of the current areas of research related to trace metals and metal-organic interactions, including analytical, thermodynamic, biochemical, and kinetic considerations presented as review papers, reports of experimental research, and theoretical models summarizing available information from the literature.

Singer, P.C. and T.L. Theis.

Anaerobic Digestion of Sludges Containing Iron Phosphates.

Journal of the Sanitary Engineering Division, ASCE.
98(5):784-786. October 1972.

Key Words: phosphates, iron, anaerobic digestion.

Abstract:

Primary sludges containing iron phosphate exhibited a significant uptake of phosphorus during anaerobic digestion, while digestion of thickened waste activated sludge resulted in a release of phosphorus.

Singley, J.E., C.J. Kirchmer, and R. Miura.

Analysis of Coprostanol, an Indicator of Fecal Contamination.

University of Florida at Gainesville, Department of Environmental Engineering Sciences, March 1974. 127p.

Key Words: coliforms, BOD, COD, total organic carbon, surface water (fresh), surface water (marine).

Abstract:
Total coliform and fecal coliform has been used as measures of water quality for uses ranging from shellfish waters to public water supplies. Because of the weaknesses of the coliform tests, research has continued in the search for indicators of fecal pollution. Coprostanol, or 5 beta-cholestan-3 betaol, has shown promise as an indicator of fecal pollution. This sterol is a characteristic fecal organic compound which is found in the feces of higher animals, including man. The gas chromatographic analysis of coprostanol was improved and a method of sample preservation was developed using H_2SO_4. Field surveys compared coprostanol analyses with total and fecal coliform and confirmed the predicted advantages of a chemical method over a biological method. The gas chromatographic method was used in extensive field surveys, in degradation studies, in treatment plant efficiency studies and as the standard for evaluation of a colorimetric method. The method was capable of determining twenty nanograms per liter, which was estimated to be equivalent to approximately two coliforms per 100 ml. An attempt was made to correlate coprostanol concentration with treatment plant efficiency. There was a reasonably good correlation between coprostanol and BOD, COD and TOC. A colorimetric method has been developed that can be used to determine coprostanol at levels of one microgram g/l in polluted water. The color developer used is dinitrophenylhydrazine.

Sinskey, A.J., D. Shah, K.A. Wright, E.W. Merrill, S. Sommer, and J.G. Trump.

Biological Effects of High Energy Electron Irradiation of Municipal Sludge.

Contribution No. 2631. Massachusetts Institute of Technology, Cambridge, Massachusetts, Department of Nutrition and Food Science, 1975. 19p.

Key Words: coliforms, bacteria, radiation treatment.

Abstract:

Since May 1, 1974 studies at M.I.T. on electron irradiation of municipal wastewater and sludge have been advanced by NSF support under RANN project GI-43112. All irradiations have been performed at the High Voltage Research Laboratory using a compressed gas-insulated 4 MeV Van de Graaff electron accelerator. This source was operated on simulated or actual sewage materials at 3 MV for most of the studies. The irradiated quantities per assay ranged from 20 to 1000 ml and the dosages from 10^4 rads to 3 x 10^6 rads. The selection of doses depended on the sensitivity of the organisms and effects under study. Treatment times were mostly close to 1 second, the electron beam current being controlled to deliver the desired dosages in this time.

Radiobiological measurements were first carried out on three typical water-borne bacteria and one bacteriophage. Conditions of irradiation were varied from the anoxic state to atmospheric air, atmospheric oxygen, and oxygen up to 15 atmospheres pressure. Later studies were made on coliform and total count reduction in municipal sludge. The studies showed that inactivation of bacteria and viruses in phosphate buffer and in sewage sludge can be obtained by electron irradiation.

A dosage of 300,000 rads was sufficient to produce a 99.99% kill in the total population present in sewage sludge. The coliforms and other gram negative organisms in sludge proved to be the most suceptible to radiation. One hundred percent inactivation of these bacteria was obtained with total dosages of less than 150,000 rads.

Sivak, A.

The Ames Assay.

Science. 193:272-273. July 23, 1976.

Key Words: epidemiology.

Abstract:

The article suggests that the Ames Assay is useful as one of a battery of first-step prescreens for chemical agents that may have the potential for interacting with cellular genomes. However, the implication that positive results in this microbial mutagenesis system will correspond to carcinogenicity in experimental animals or in humans does not appear, at present, to be substantiated.

Skerfving, S., K. Hansson, and J. Lindsten.

Chromosome Breakage in Humans Exposed to Methylmercury through Fish Consumption: Preliminary Communication.

Archives of Environmental Health. 21:133-139. August 1970.

Key Words: mercury, fish.

Abstract:

Chromosome analysis was performed on cells from lymohocycle cultures from nine subjects with increased levels of mercury in their red blood cells and in four healthy controls. The elevated mercury levels were likely to have originated from dietary fish with high levels of methyl mercury. A statistically significant rank correlation was found between the frequency of cells with chromosome breaks and mercury concentration. The biological significance of these findings is at present unknown.

Skinner, Q.D.

Bacteriology of Streams and the Associated Vegetation of a High Mountain Watershed.

University of Wyoming, Laramie, Water Resources Research Center, December 1974. 9p. (Available from National Technical Information Service (NTIS) as PB-241 140).

Key Words: coliforms, bacteria, surface water (fresh).

Abstract:

The major objective of the research was to relate variations of bacteria count with vegetative types; range conditions; and various uses of watershed. Results show that the range conditions of the Nash Fork study area can be classified as being in good condition. There exists a seasonal variation in the various bacteriological groups monitored. Total coliforms, fecal coliforms and enterococci reach peak concentrations in late summer. The main source of pollution appears to be animals rather than humans. There existed little difference in variations of bacteria counts between vegetation types, with the exception of nitrate reducing bacteria which had higher counts below wet meadows. The ski area had an effect on bacteria counts during the operating season.

Sklarow, S.S., R.R. Colwell, G.B. Chapman, and S.F. Zane.

Characteristics of a *Vibrio parahaemolyticus* Bacteriophage Isolated from Atlantic Coast Sediment.

Canadian Journal of Microbiology. 19(12):1519-1520. 1973.

Key Words: viruses, surface water (marine).

Abstract:

Although bacteriophages active against marine bacteria have been isolated, there are no extensive studies of bacteriophages from seawater and sediment. There are, however, some reports of isolation of marine bacteriophages. Because *Vibrio parahaemolyticus* has been shown to be involved in food poisoning (via ingestion of contaminated seafood) and because bacteriophages active against this organism have been isolated by Japanese workers, it was decided to seek bacteriophages for the organism from the offshore sediments for phage-typing purposes. We have succeeded in isolating bacteriophages for *V. parahaemolyticus*. This report characterizes a *V. parahaemolyticus* bacteriophage derived from one such sediment sample.

Skripach, T., V. Kagan, M. Romanov, L. Kamen, and A. Semina.

Removal of Fluorine and Arsenic from the Wastewater of the Rare-Earth Industry.

Advances in Water Pollution Research. 1970(2):III-34/1-7.

Key Words: arsenic, fluorides, chemical treatment.

Abstract:

1. Cleaning industrial wastewaters for fluorine must be effected with calcium oxide. The reagent consumption is 200% of the amount stoichiometrically required. Agitation time (without heating) is 45 minutes. The residual fluorine content in the purified water is some 15-20 mg/l.

It is recommended to make a final cleaning for small amounts of fluorine (from 20 mg/l down to the sanitary level of 1.5 mg/l) with superphosphate and calcium oxide or with aluminium sulphide. Superphosphate consumption (on PO_4^{3-} basis) is 300% of the amount stoichiometrically required. Agitation time (without heating) was 2 hours. Aluminium sulphide consumption was 4 g/l, agitation time -- 1.5 hours, pH value -- 7, sedimentation time -- 2 hours.

2. The feasibility was shown of using ion-exchange resins and membranes for cleaning wastewater for fluorine and other ions (NO_3^-, SO_4^{2-}, Cl^-).

3. Cleaning industrial wastewaters for arsenic must be effected with calcium oxide (pH value of about 8 and process time of about an hour). Iron must be present in an amount which assures total removal of arsenic compounds (5 times the arsenic for five-valent and 10 times for three-valent arsenic compounds).

4. Cleaning industrial wastewaters not containing iron salts must be conducted in the following way:

4.1. Oxidizing the three-valent aresenic compounds into the five-valent ones with 30% H_2O_2 and then treating with calcium oxide (pH value of about 8, agitation time some 15-20 minutes). Observing these conditions guarantees attaining the sanitary level of arsenic content in the wastewater purified.

4.2. Oxidizing the three-valent arsenic compounds into the five-valent ones with pyrolusite and then

treating with calcium oxide (pH value about 9-10, and agitation time - 1 hour). When these conditions are observed, arsenic content in the purified water is 0.2 mg/l and requires a 4-fold dilution of the wastewater purified before letting it go back into a water pool.

Slanetz, L.W.

Additional Recommendations for Future Research Regarding Indicator Bacteria and Pathogens Associated with Wastewater Treatment and Disposal Systems.

University of New Hampshire, Durham, 1975. 2p.

Key Words: *Escherichia coli*, fecal streptococci, coliforms, surface water (fresh), surface water (marine).

Abstract:

This article summarizes the need for research for isolation of pathogenic organisms other than standard filtration methods because of possible inaccuracies in the latter.

Slanetz, L.W. and C.H. Bartley.

Survival of Fecal Streptococci in Sea Water.

Health Laboratory Science. 2(3):141-148. July 1965.

Key Words: fecal streptococci, surface water (marine).

Abstract:

Fecal streptococci did not increase in numbers to any appreciable extent when suspended in sea water or sewage effluent in cellophane bags and suspended in New Hampshire Bay waters at the mouth of a river estuary. There was generally a decrease of 50-85 percent in the original numbers of these organisms within the first 1-2 days with practically complete die-off within 7-11 days.

Coliforms and fecal coliforms in sewage effluent were found to increase in number during the first 1-4 day period of immersion in this bay water. A marked die-off of the bacteria then occurred during the next 4-6 days of exposure. Cells from pure cultures of E. coli suspended in cellophane bags in the sea water showed similar survival curves except that growth occurred during the first 24 hr period of immersion and a rapid die-off developed during the next 3 day period. The survival curves of suspensions of cells from pure cultures of Salmonella resembled those obtained for E. coli, although the die-off rate was somewhat slower.

If appreciable organic or nutrient material is present in sewage contaminated sea water, the numbers of fecal streptococci in such water may give a more accurate estimate of the degree of pollution than coliforms or fecal coliforms since they do not multiply in such water and they show appreciable die-off rates within a 2-3 day period.

Slanetz, L.W., C.H. Bartley, and K.W. Stanley.

Coliforms, Fecal Streptococci and Salmonella in Seawater Shellfish.

Health Laboratory Science. 5(2):66-78. April 1968.

Key Words: coliforms, fecal streptococci, salmonella, surface water (marine), shellfish.

Abstract:

The numbers or presence of coliforms, fecal coliforms, fecal streptococci and salmonellae were determined for samples of seawater and oysters collected during sampling periods from April to November, 1964, 1965 and 1966. Membrane filter procedures proved highly useful and efficient for the enumeration of both coliforms and fecal coliforms in the seawater samples, although the numbers of coliforms were in general somewhat lower than the counts obtained by the multiple-tube fermentation (MPN) tests. The fecal streptococci were also efficiently enumerated in the seawater samples by the membrane filter procedure and in the oyster samples by a plating technic, (sic) using m-enterococcus agar. Tests for fecal coliforms and fecal streptococci were found to be highly useful for assessing the degree of fecal contamination of seawater and shellfish. Effective procedures were developed for the isolation of salmonellae from seawater and oysters. A number of different salmonella aerotypes were isolated from such samples, including samples of seawater and oysters collected from shellfish-growing areas which met the current recommended coliform standard for approved shellfish-growing waters.

Slanetz, L.W., C.H. Bartley, T.G. Metcalf, and R. Nesman.

Survival of Enteric Bacteria and Viruses in Oxidation Pond Systems.

University of New Hampshire, Durham, 1972. 35p.

Key Words: coliforms, fecal streptococci, salmonella, trickling filter, ponding/land application.

Abstract:
This is a report on the survival of enteric bacteria and viruses in an oxidation pond system during certain times of the year.

Smith, E.C., F. Berkes, and J.A. Spence.

Mercury Levels in Fish in the La Grande River Area,
Northern Quebec.

Bulletin of Environmental Contamination and Toxicology.
13(6):673-677. June 1975.

Key Words: mercury, fish.

Abstract:
This paper deals with mercurial content of freshwater fish. The region under study does not have any industry so this paper may provide some basis for comparison. In addition, because this is a cold weather region, possible comparisons may be drawn concerning the effect of temperature and mercurial uptake with data from temperate regions.

Smith, F.A., R.P. Sharma, R.L. Lynn, and J.B. Low.

Mercury and Selected Pesticide Levels in Fish and Wildlife of Utah. I. Levels of Mercury, DDT, DDE, Dieldrin and PCB in Fish.

Bulletin of Environmental Contaminants and Toxicology. 12:218-223. February 1974.

Key Words: mercury, DDT, DDE, dieldrin, chlorinated hydrocarbons, fish.

Abstract:

This is an excellent paper on uptake levels in fish of mercury and various pesticides.

Smith, J.E., K.W. Young, and R.B. Dean.

Biological Oxidation and Disinfection of Sludge.

Water Research. 9:17-24. 1975.

Key Words: viruses, bacteria, nitrates, aerobic digestion, heat treatment.

Abstract:

Aerobic thermophilic digestion of sludge destroys human pathogens. No nitrates were measured in the digested sludge because nitrifying organisms do not grow at the higher temperatures in the digester.

Smith, J.M., A.N. Masse, W.A. Feige, and L.J. Kamphake.

Nitrogen Removal from Municipal Waste Water by Columnar Denitrification.

Environmental Science and Technology. 6(3):260-267. March 1972.

Key Words: ammonia, nitrates, nitrification/denitrification.

Abstract:

Among the available methods to remove nitrogen from waste water, the biological method of denitrification appears most promising. The work reported herein describes the results of a pilot plant investigation of columnar denitrification on three sizes of inert media, utilizing methanol as a substrate for the biochemical reduction of the nitrate ion. These studies were conducted on the nitrified effluent of a municipal waste treatment plant receiving sewage of domestic origin. The work was directed toward extending the state of the art of columnar denitrification and to specifically define the optimum conditions for this process. The effects of media size, gradation, column porosity, and contact time, and the effect of influent dissolved oxygen on nitrate reduction efficiency were determined. Hydraulic characteristics and solids removal efficiencies were examined for each column. Results indicated that greater than 90% denitrification was achieved at methanol/nitrate ratios of 2.50/1.0 and 2.75/1.0 at contact times of 5 min for coarse sand and 15 min for 3/4-in. stone.

Smith, R.J., R.M. Twedt, and L.K. Flanigan.

Relationships of Indicator and Pathogenic Bacteria in Stream Waters.

JWPCF. 45(8):1736-1745. August 1973.

Key Words: salmonella, fecal streptococci, coliforms, surface water (fresh), effluent characteristics.

Abstract:

In profile studies, the pattern of average salmonella concentrations in the Saline River followed that of all three indicator groups although exhibiting an apparent 3-mile (4.8-km) lag. The similarity of the average salmonella concentration in the Huron River to any one indicator group was not clear, although the resemblance to total coliforms was closest. The fecal coliforms constituted less than a third of the total coliform concentration for both rivers and was generally about 20 percent.

In samples from which salmonellae were isolated, the geometric mean ratios relating indicators to pathogens were 1 salmonella to 1,472 coliforms, 227 fecal coliforms, and 367 fecal streptococci in the Saline River and 1 salmonella to 274 coliforms, 24 fecal coliforms, and 109 fecal streptococci in the Huron River. These ratios were lower, by a factor of roughly 10, than those previously presented. This may be the result of the improved effectiveness of the salmonellae isolation technique used in the present work over that used previously. The combination of DSE and XLD media used here was recently shown by Kenner to yield more salmonella isolations from wastewater and polluted and unpolluted stream waters than any other conventional media. Nevertheless, these data revealed that the probability for salmonella isolation decreased as the fecal coliform concentration increased, suggesting that the media were not able to overcome the larger concentrations of competitive microflora and chemical wastes which accompanied increasing levels of pollution.

The present quantitative analysis confirms what researchers had found with regard to the difficulty of establishing the natural relationships of indicators and pathogens in stream waters. Apparently the relationship is tempered by such important factors as the nature of seasonal pollution and the numbers of salmonella excreters among the human and

animal populations in the drainage basin. High fecal coliform levels can occur in conjunction with low salmonella densities and conversely. Nevertheless, the usefulness of the fecal coliform concentration for making a qualified judgment of water quality has been reconfirmed.

Smith, S.J. and R.J. Davis.

Relative Movement of Bromide and Nitrate through Soils.

Journal of Environmental Quality. 3:152-155. April 1974.

Key Words: nitrites, bromide, groundwater.

Abstract:

Miscible displacement experiments were conducted with eight different surface soils (0-15 cm depth) and their associated subsoils (61-76 cm depth). Results indicate that the movement of bromide relative to that of nitrate (0.005 N salts) is identical in subsoils but variable in surface soils. Differences in relative movement of the two anions may be attributed to microbial activity involving nitrate.

With the exception of 5% anion sorption in a Greenville subsoil, anion exclusion values ranged from 5 to 30% indicating the anions were moving 1.05 to 1.64 times as fast as they would if they had been uniformly associated with all the soil water. The results support the view that bromide has utility for following the potential path of nitrate movement through soils.

Smith, S.O.

Iron Occurrence in Ground Water Correlated With Dissolved Oxygen.

Public Works. 101:60-62. February 1970.

Key Words: iron, groundwater.

Abstract:

The quality of water derived from the major public water supply aquifers in Nassau County, N.Y. can be characterized as naturally corrosive, being soft and acidic, and frequently containing a high concentration of dissolved oxygen.

Approximately 66 percent of the water supplies provide treatment for corrosion control and plans are being implemented for corrosion control in some of the remaining water supplies.

There are areal differences in natural iron and dissolved oxygen content in the county; lines of equally dissolved oxygen content roughly follow the contour lines of the groundwater table. This appears to indicate that the dissolved oxygen in the underground formations depletes following the general flow of groundwater. The presence of dissolved iron is related to the deficiency of dissolved oxygen.

Snodgrass, W.J. and C.R. O'Melia.

Predictive Model for Phosphorus in Lakes.

Environmental Science and Technology. 9(10):937-944.
October 1975.

Key Words: surface water (fresh).

Abstract:

A predictive model for phosphorus in lakes has been developed and verified. The model shows excellent agreement between observed and predicted average phosphorus concentrations for lakes with a wide range of hydraulic detention times (1-700 years) and mean depths (14-313 meters). At present the model should be applied only to lakes with oxic hypolimnetic waters. The model has been verified for conditions of constant nutrient loadings. The model provides an explanation for the effects of mean lake depth on water quality noted by several limnologists. Vertical exchange of phosphorus forms across the thermocline and natural aggregation within the lake are important processes for the transport and deposition of phosphorus in lakes. The significance of these processes increases with lake depth.

Snoeyink, V.L. and F.I. Markus.

Chlorine Residuals in Treated Effluents.

Illinois Institute of Environmental Quality, Chicago, August 1973. 65p. (Available from National Technical Information Service (NTIS) as PB-227 268).

Key Words: synthetic/organics, chlorination.

Abstract:

This study was concerned with the occurrence and effect of residual chlorine in treated wastewater effluents. A field study which involved analysis of effluents from 20 wastewater treatment plants in Central Illinois showed total chlorine residuals ranging from 1 to 5 mg/1. Most of these plants discharged to streams which have 7-day 10-year low flows of zero. A study was made of the rate of decay of residuals in receiving waters, and this rate proved to be an important function of the type of residual (i.e., free or combined) and the amount of sunlight. Free chlorine in secondary effluent exposed to bright sunlight decayed most rapidly. Chlorine residual can be eliminated by chemical reduction of the residual either by sulfur compounds (SO_2, HSO_3^-, $SO_3^=$) or activated carbon.

Snoeyink, V.L. and F.I. Markus.

Chlorine Residuals in Treated Effluents.

Water and Sewage Works. 121(4):35-38. April 1974.

Key Words: ammonia, chlorination, surface water (fresh).

Abstract:

Chlorine residuals in the concentration range of 1 to 5 mg/l as Cl_2 are being discharged to receiving waters in central Illinois as a result of chlorination of effluents for disinfection. The residual is predominantly monochloramine and in most instances it is being discharged to streams which provide little dilution. Other research has shown that chlorine residual imparts a definite toxicity to the discharge; stream criteria of 0.002 to 0.2 mg/l total chlorine residual have been recommended, depending on the type of fish to be protected in the receiving water and on whether the residual is continuously or intermittently present. If these criteria are in effect, dechlorination is necessary in many instances.

Dechlorination can readily be achieved by use of sulfur compounds, such as SO_2, or by the use of activated carbon. A major advantage in the use of activated carbon is that it can also be used to achieve ammonia removal. If reduction in ammonia concentration in a particular discharge is required in addition to dechlorination, this advantage is highly significant.

Snoeyink, V.L., H.T. Lai, J.H. Johnson, and J.F. Young.

Active Carbon: Dechlorination and the Adsorption of Organic Compounds.

In: Chemistry of Water Supply, Treatment, and Distribution. J. Rubin, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1975. pp. 233-252.

Key Words: chlorides, adsorption/ion exchange.

Abstract:

A definite relationship exists between the buildup of acidic surface oxides and the degree of treatment with free chlorine. The surface has a maximum level of oxides that it can accommodate, but many of the oxides or oxygen-containing reaction products formed via reaction with free chlorine are volatile. This volatility undoubtedly results in a much longer life for the dechlorination capability of active carbon beds. The brown colloidal matter that appears as a product after extensive reaction with chlorine is not of major concern because the useful life of field dechlorination units is exceeded before this product appears.

The reaction products which were readily washed from the carbon surface, or volatilized during drying of the carbon, apparently had no major affect on the adsorption capacity of the carbon for the aromatics studied. The presence of fixed oxides, however, reduced adsorption capacity. This fact should be taken into account if carbon beds are to be used for both dechlorination and removal of dissolved organics.

Several topics related to this study require further investigation. The effect of acidic surface oxides on adsorption of more polar compounds should be investigated because it is possible that adsorption of these types of compounds will be increased with oxide buildup owing to dipole-dipole interactions between the molecule and the surface. The rate of oxide buildup under low but prolonged levels of free chlorine application should be studied. Also, the effect of organic molecules on the carbon surface on the rate of dechlorination and the life of the dechlorination bed needs to be evaluated if conjunctive use for dechlorination and adsorption is contemplated. The character of the reaction products, such as the acidic reaction products that are removed from the carbon when it is heated, should also be

studied. It would also be desirable that more in-depth studies be undertaken relating to changes in surface area and pore size distribution to the effect of acidic surface area and pore size distribution to the effect of acidic surface oxides on adsorption of organic compounds.

Snoeyink, V.L., W.J. Weber, and H.B. Mark.

Sorption of Phenol and Nitrophenol by Activated Carbon.

Environmental Science and Technology. 8:918-926.
October 1969.

Key Words: synthetic/organics, adsorption/ion exchange.

Abstract:

Equilibrium measurements of the sorption of phenol and p-nitrophenol from aqueous solution by active carbon suggest a heterogeneity of active surface sites with respect to energy of adsorption. Desorption studies show the presence of significant hysteresis effects when long equilibration periods are involved, although these effects are much smaller when adsorption-desorption equilibria are attained more rapidly. Differences in surface properties for different carbons is suggested by more extensive sorption of phenol at lower surface coverages on a coconut carbon than on a coal carbon of similar surface area. Further, again for low surface coverages and the same coconut carbon, p-nitrophenol is sorbed more extensively than phenol. At higher surface coverages the sorption is apparently less specific, andthe sorption isotherms tend to converge. Studies at various pH levels indicate that the capacity of active carbon for adsorption of the anionic forms of both phenol and p-nitrophenol is less than for the corresponding neutral species. There is no marked effect of pH on the sorption of the neutral form of p-nitrophenol in the pH range from 2.0 to 6.5. The capacity for the neutral phenol molecule decreases significantly with decreasing pH in this same range, however, suggesting that the hydrated proton competes effectively with phenol for active surface sites.

Sobsey, M.D.

Enteric Viruses and Drinking-Water Supplies.

JAWWA. 67(8):414-418. August 1975.

Key Words: viruses, drinking and recreational water.

Abstract:

Although waterborne virus detection methodology should be further developed and improved, reasonably sensitive and reliable methods are now available to quantitiate small amounts of enteric viruses in up to 100-gal volumes of drinking water. The two most promising methods for this type of water are flow-through, filter adsorption-elution systems, and certain types of ultrafiltration systems.

It should be recognized that it is impossible to eliminate all fecal contamination from drinking-water supplies. Surveillance studies to determine enteric virus levels in drinking waters meeting current microbial standards should be a major priority for research on viruses in water. It is only by knowing the extent of enteric virus contamination of currently acceptable drinking-water supplies that scientists can begin to determine if current microbial drinking-water standards are adequate with respect to enteric viruses.

Sobsey, M.D., C. Wallis, and J.L. Melnick.

Studies on the Survival and Fate of Enteroviruses in an Experimental Model of a Municipal Solid Waste Landfill and Leachate.

Applied Microbiology. 30(4):565-574. October 1975.

Key Words: viruses, epidemiology.

Abstract:

In laboratory scale municipal solid waste lysimeters containing simulated refuse, and seeded with either laboratory or field strains of poliovirus type 1 and echovirus type 71 viruses were not detected in the lysimeter leachate produced over a 4-month period. In addition, viruses were not detected in the lysimter refuse contents after termination of lysimeter operation. These results appeared to be due to virus retention in the lysimeter caused by virus adsorption and virus inactivation. Evidence for virus inactivation was provided by the results of experiments on virus inactivation in composite leachate samples. Evidence for virus adsorption was supported by the rapid adsorption of viruses to various municipal solid waste components in the presence of a salt solution similar in composition to the major inorganic salts of leachates.

Sobsey, M.D., C. Wallis, M.F. Hobbs, A.C. Green, and J.L. Melnick.

Virus Removal and Inactivation by Physical-Chemical
Waste Treatment.

Journal of the Environmental Engineering Division,
ASCE. 99(EE3):245-252. June 1973.

Key Words: polio virus, adsorption/ion exchange, chemical treatment, chlorination, filtration.

Abstract:

From the results of this study it is concluded that the physical chemical wastewater treatment system studied is capable of reducing the enteric virus content of wastewater by more than 99.95%. This degree of virus removal is superior to that obtained with conventional primary and secondary wastewater treatment, since field studies have shown that virus removal is generally no more than 90% to 99% in these treatment systems.

Studies are now being conducted on this wastewater treatment system to improve virus removal from the effluent and to inactivate the virus in the filter cake.

Södergren, A. and B. Svensson.

Uptake and Accumulation of DDT and PCB by Ephemera danica (Ephemeroptera) in Continuous-Flow Systems.

Bulletin of Environmental Contamination and Toxicology. 9(6):354-350. June 1973.

Key Words: chlorinated hydrocarbons, DDT, fish.

Abstract:
The authors found that the accumulation of DDT and PCB followed a kinetic equation of the first order in the test organisms.

Soldano, B.A., P. Bien, and P. Kwan.

Air-Borne Organo-Mercury and Elemental Mercury Emissions with Emphasis on Central Sewage Facilities, and Discussion.

Atmospheric Environment. 9:941-944. April 10, 1975.

Key Words: mercury, groundwater, surface water (marine), surface water (fresh), crops, livestock, fish, shellfish, drinking and recreational water, air.

Abstract:

Field studies strongly suggest that central sewage facilities consitutute a widespread source of organic mercury as well as elemental mercury emissions. The authors have found evidence for organic and elemental mercury emissions covering a concentration range greater than 10^7. These findings are based on air samples obtained in cities with populations ranging from 20,000 to 700,000. Particular emphasis was given to meterological and spatial factors relative to central sewage facilities. The concentration of elemental mercury in the atmosphere falls off sharply with increasing distance from the central sewage plant. That of the more volatile organic forms of mercury increases (for at least several miles) with distance. The concentration maxima of the organic mercury emissions appear to be related to population size.

Sopper, W.E.

Crop Selection and Management Alternatives -- Perennials.

In: Recycling Municipal Sludges and Effluents on Land, Proceedings of the Joint Conference, July 9-13, 1973. pp. 143-153.

Key Words: ponding/land application, adsorption/ion exchange.

Abstract:

It appears that there is sufficient evidence to indicate that perennial vegetation can be utilized as part of the land management system of a municipal wastewater disposal site. There is still, however, a need for much definitive research data on almost all aspects concerning the long-term environmnetal impacts on the entire biosystem.

Sopper, W.E.

Disposal of Municipal Waste Water through Forest Irrigation.

Environmental Pollution. 1(4):263-284. April 1971.

Key Words: nitrates, phosphates, ponding/land application, direct contact.

Abstract:

Serious pollution problems are often created by the disposal of municipal waste water into surface waters. An obvious alternative method is diversion of these waste waters to the land. Such non-aqueous methods of disposal might eliminate or alleviate many water pollution problems and, in some cases, could even provide secondary benefits such as recharge of groundwater reservoirs, and increased production of crops and wood fibre. Research results indicate that, with properly programmed application rates, large volumes of waste water can be satisfactorily renovated through irrigation of forestland, and considerable amounts of high-quality water recharged to the groundwater reservoir. In addition, secondary benefits such as increased tree growth, increased site productivity, and site amelioration have also been obtained. The deliberate reclamation of waste water for potential reuse is one of the keys to optimum utilization of our water resources. Such reclamation for reuse will receive increased attention in the future as we struggle to improve our environment and maintain an equilibrium with nature.

Sopper, W.E. and L.T. Kardos.

Vegetation Responses to Irrigation with Treated Municipal Wastewater.

In: Conference on Recycling Treated Municipal Wastewater through Forest and Cropland. EPA-660/2-74-003, Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp. 242-269.

Key Words: ammonia, nitrates, phosphates, chlorides, agriculture.

Abstract:

Sewage effluent irrigation during the past 10 years on cropland and in forestland has, for the most part, produced beneficial vegetation responses. Crop yields and tree growth were significantly increased. In addition the value of the vegetation as a renovating agent has been demonstrated to be a vital part of the system. For year-around operations a combination of cropland and forestland will provide the greatest flexibility in operating a system using the "living filter" concept.

Sopper, W.E., L.T. Kardos, and B.R. Edgerton.

Using Sewage Effluent and Liquid Digested Sludge to Establish Grasses and Legumes on Bituminous Strip-Mine Spoils.

Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. 165p. (Available from National Technical Information Service (NTIS) as PB-232 069).

Key Words: ammonia, nitrates, nitrites, crops.

Abstract:

Six large lysimeters were filled with strip-mine spoil material. The spoil was then seeded with eight grass and eight legume species and then treated with sewage effluent and liquid digested sludge at the following treatment rates: control (no treatment), one-inch effluent plus one-inch sludge combination (1E + 1S), and two-inch effluent plus two-inch sludge combination (2E + 2S). The spoil was irrigated weekly during the period May 24 to September 21, 1972. The results indicated that treatment ameliorated the harsh site conditions and greatly facilitated establishment of the grasses and legumes. The grasses did much better than the legumes in both dry matter production and percent areal cover of the spoil. Highest concentrations of metals and lowest concentrations of nitrogen were found in leachate from the control spoil. Leachate from spoil receiving the 2E + 2S treatment had the lowest concentrations of metals and acidity, and the highest concentrations of nitrogen, more favorable for grass and legume establishment.

Sorber, C.A.

Protection of the Public Health.

In: Proceedings of the Conference on Land Disposal of Municipal Effluents and Sludges. EPA-902/9-73-001, Rutgers - the State University of New Jersey, March 1973. pp. 201-209.

Key Words: epidemiology, ponding/land application.

Abstract:
There are very few, if any, public health problems that have been demonstrated as a result of spray irrigation or land disposal of wastewater. However, a significant number of questions have been raised, and it appears to be judicious to conduct well planned investigations which will demonstrate beyond a shadow of doubt whether these potential problems do or do not exist.

Sorber, C.A. and K.J. Guter.

Health and Hygiene Aspects of Spray Irrigation.

Public Health. 65(1):47-52. January 1975.

Key Words: total dissolved solids, suspended solids, nitrates, nitrites, zinc, chromium, copper, lead, manganese, *Vibrio cholerae*, shigella, mycobacterium, coxsackie virus, polio virus, ECHO virus, parasitic worms, agriculture.

Abstract:

The following conclusions relative to the health and hygiene effects of spray irrigation land disposal of wastewater can be drawn:

1. Many of the detrimental health and hygiene aspects of land disposal should be significantly reduced by proper wastewater pretreatment including secondary treatment, filtration, and complete disinfection.

2. By choosing a land disposal site that has from 5 to 10 feet of continuous fine soil, biological contamination of groundwater can be avoided.

3. The probability of inhaling pathogenic aerosols near a spray irrigation site may be significant.

4. If ponding results in spray irrigation areas, mosquito breeding is enhanced.

5. In areas where land disposal is the first step in a water recycle program, total dissolved solids, sodium, and nitrate-nitrogen buildup in the groundwater supply can be a problem.

Sorber, C.A., S.A. Schaub, and H.T. Bausum.

An Assessment of a Potential Virus Hazard Associated with Spray Irrigation of Domestic Wastewaters.

In: Virus Survival in Water and Wastewater Systems. J.F. Malina, Jr. and B.P. Sagik, eds. University of Texas at Austin, Center for Research in Water Resources, 1974. pp. 241-252.

Key Words: viruses, ponding/land application.

Abstract:

Based on the factors described and the assumptions made in modeling field conditions, the following conclusions can be drawn:

1. Secondary treatment, especially trickling filtration, and common disinfection practices cannot be relied upon to provide appreciable virus reduction in wastewaters.

2. Under many spray irrigation site conditions, the use of distance is undesirable as the sole design criterion for reduction of virus aerosols.

3. A positive design approach to minimize the virus aerosol risk is to remove or destroy viruses in the pretreatment process prior to spraying.

Sorber, C.A., H.T. Bausum, and S.A. Schaub.

Bacterial Aerosols Created by Spray Irrigation of Wastewater.

Presented at the 1975 Sprinkler Irrigation Association Technical Conference, Atlanta, Georgia, February 1975. 16p.

Key Words: bacteria, ponding/land application, air.

Abstract:

Although this paper deals with preliminary analysis of recent field studies on bacterial aerosols generated at a spray irrigation site, the following conclusions can be drawn with reasonable assurance:

1. Relatively high concentrations of bacterial aerosols can be transmitted for considerable distances under the conditions of spray irrigation studied.

2. Most of the bacteria are contained in aerosols which are in the respirable range.

3. After initial aerosol shock and desiccation, sunlight had little effect on bacterial decay for the aerosol ages studied.

4. The most important factors having a bearing on the downwind aerosol concentrations observed are the concentration of organisms at the source and atmospheric stability.

5. The highest concentrations of bacterial aerosols at a downwind point occurred under stable atmospheric conditions which are characterized by low wind velocities and darkness.

6. Effective disinfection can reduce these aerosols to background levels in reasonable distances.

Sorber, C.A., S.A. Schaub, and K.J. Guter.

Problem Definition Study: Evaluation of Health and Hygiene Aspects of Land Disposal of Wastewater at Military Installations.

U.S. Army Medical Environmental Engineering Research Unit, Edgewood Arsenal, Maryland, 1972. 32p.

Key Words: nitrites, viruses, coliforms, bacteria, ponding/land application, groundwater, air, direct contact, agriculture, chlorination, ozonation, composting.

Abstract:

The following conclusions relative to the health and hygiene effects of land disposal of wastewater can be drawn:

1. Many ofthe detrimental health and hygiene aspects of land disposal would be significantly reduced by proper wastewater pretreatment, including secondary treatment, filtration and complete disinfection.

2. By choosing a land disposal site that has from five to ten feet of continuous fine soil, biological contamination of groundwater should be avoided.

3. The probability of inhaling pathogenic aerosols near a spray irrigation site is significant.

4. Chemical components of sewage may enhance the viability of bacteria, virus and protozoans in aerosols.

5. Pathogenic microorganisms (bacteria and viruses) may survive longer in sewage aerosols and in soil than common indicator organisms such as coliform organisms.

6. As a result of ponding in land disposal areas, mosquito breeding is enhanced.

7. In areas where land disposal is the first step in a water recycle program, total dissolved solids, sodium and nitrate ion build-up in the groundwater supply can be a problem.

Sorber, C.A., J.F. Malina, Jr., and B.P. Sagik.

Quantitative Procedure for Evaluating the Performance of Water and Waste Water Treatment Processes at Naturally Occurring Levels.

Environmental Science and Technology. 6(5):438-441. May 1972.

Key Words: viruses, epidemiology.

Abstract:

The data presented indicate the effectiveness of insoluble polyelectrolytes for concentrating extremely low levels of viruses from artificial and natural waters. T2 coliphage recoveries are reliable and reproducible at about 25% of added virus at optimal pH. The ability of the PE 60 to adsorb essentially 100% of the virus in the suspension at the dose and mixing time employed was also demonstrated. Control of the pH is critical for reproducible results using the coliphage.

The major purpose of this study was the standardization of a method for quantitating the effectiveness of water and waste water treatment methods for the removal of viruses at naturally occurring concentrations. The technique described satisfies that need and provides a relatively simple method of virus concentration which is highly reproducible over a broad range of virus levels. However, standardization of the polyelectrolyte for the virus used in a study is essential.

The largest sample of water handled in this investigation was 18 liters. Experimental data indicate that the results can be applied to any manageable volume of water. Additional investigations are in progress at this time with the purpose of simplifying the mechanical problems associated with handling several hundred liters of water, although volumes of 5 and 10 liters would seem to be large enough for most bench and pilot scale studies.

Southern California Coastal Water Research Project Annual Report.

Southern California Coastal Water Research Project. El Segundo, California, June 30, 1974. 197p.

Key Words: chromium, viruses, coliforms, bacteria, *Vibrio cholerae*, *Escherichia coli*, salmonella, *shigella*, mycobacterium, *Staphylococcus aureus*, ammonia, BOD, COD, cyanides, nitrates, oil and grease, phosphates, suspended solids, total dissolved solids, total organic carbon, arsenic, cadmium, copper, iron, manganese, mercury, nickel, lead, selenium, zinc, antibiotics, DDT, dieldrin, organophosphorous pesticides, antimony, surface water (marine), surface water (fresh).

Abstract:

This is a precise study of the relationship between plant and animal life and the condition of the coastal water of Southern California, the chemistry and biology of coastal water and the problems related to it and possible solutions.

Southern California Coastal Water Research Project Annual Report.

Southern California Coastal Water Research Project. El Segundo, California, June 30, 1975. 211p.

Key Words: DDT, chlorinated hydrocarbons, chromium, viruses, coliforms, fecal streptococci, *Staphylococcus aureus*, bacteria, surface water (marine), fish, shellfish, air.

Abstract:

This report includes studies on pathogenic and indicator bacteria, viruses in seawater, DDT and PCB in diseased fish, metals in polycheates, shellfish, and diseased fish, trace metals in seawater, the effects of ocean sludge disposal, and the characteristics of municipal wastewater discharges.

Sparr, A.E. and V. Gruppi.

Gravity Thickeners for Activated Sludge.

JWPCF. 41(11):1886-1904. November 1969.

Key Words: suspended solids, gravity thickeners.

Abstract:

Several of the mechanical thickening aids discussed in the paper have been incorporated in the current design of the gravity thickeners for the 17-mgd (64,300 cu m/day) Linden-Roselle Sewerage Authority (New Jersey) secondary treatment facilities. Included were mechanical deflector (compactors) plates and four rake arms equipped with pipe pickets.

In addition to recycled digested sludge these two thickeners will receive thin primary sludge and waste activated sludge in the ratio of one-to-three on a dry solids basis. It is anticipated that the additional rake arms and the compactor plates will give the settled solids added kneading with compaction and move these solids more rapidly to the sump. The net result should be a more concentrated sludge removed and a lower sludge detention time (sludge volume ratio). The short pipe pickets should provide adequate passage for the escape of any gases that may develop.

Existing circular thickeners could be modified to a limited degree for the utilization of compaction plates for improved thickening. The limiting factor would be torque capacity of the mechanical scraping mechanism - rake arms, cage, and drive. It is believed that addition of one, two, or three plates per arm could produce significant additional concentrations.

Spear, R.C., D.L. Jenkins, and T.H. Milby.

Pesticide Residues and Field Workers.

Environmental Science and Technology. 9(4):308-313.
April 1975.

Key Words: organophosphorus pesticides, epidemiology.

Abstract:

This article includes summaries of the incidence of systematic illness from exposure to organophosphorous pesticides (OP) for agricultural workers in California, 1949-1974.

Factors affecting residue intoxication and regulatory aspects are discussed.

Spody, B. and S.D. Adams.

Improved Activated Sludge Treatment with Carbon.

Deeds and Data. January 1976. 8p.

Key Words: ammonia, BOD, suspended solids, activated sludge, surface water (fresh).

Abstract:
The effect of powdered carbon on the vacuum filtration of mixed primary and waste activated sludges is discussed.

Spohr, G. and A. Talts.

Phosphate Removal by pH Controlled Lime Dosage.

Public Works. 101:63-66. July 1970.

Key Words: phosphates, chemical treatment.

Abstract:

1) Lime addition to wastewater prior to primary sedimentation can be effectively accomplished by a continuous lime slurry feed based on closed loop pH control.

2) Total phosphate removal is affirmed as being possible and practicable in such a process, the efficiency of removal being based on raw sewage characteristics and lime dosages.

3) Suspended Solids, BOD and COD reduction can be significantly enhanced by such treatment, the incremental additional removals correlating with lime dosages (effluent turbidity negates increased suspended solids removals at high pH values).

Sproul, O.J.

Virus Inactivation by Water Treatment.

JAWWA. 64(1):31-35. January 1972.

Key Words: viruses, chemical treatment, chlorination, adsorption/ion exchange.

Abstract:

The recent research literature shows that nearly all of the water-treatment processes in present use are under research investigation in order to define better their virus-removal capacity. Some of the recent efforts have defined the basic mechanisms of virus removal. A better understanding and more positive operation of treatment plants would result if greater research efforts were made in this direction.

If the virus problem in water supplies is actually as large as the recent scientific and popular literature indicates, then research needs and research efforts stand in the same relationship as a mountain to a molehill. No research effort at all in the past 10 yr has been given to virus removal by filtration. Yet over the same period this process, in some plants, has become the only treatment unit--performing the roles of flocculation chamber, sedimentation tank, and filter.

Answers through research could be obtained if some reorientation of priorities within the water-utility industry, among researchers and among funding agencies, were to take place so as to encourage a bigger effort.

Sproul, O.J., M. Warner, L.R. La Rochelle, and D.R. Brunner.

Virus Removal by Adsorption in Waste Water Treatment Process.

Advances in Water Pollution Research. 1969:541-554.

Key Words: viruses, polio virus, adsorption/ion exchange, chemical treatment.

Abstract:

The following statements and conclusions can be made on the data presented here:

1. Activated carbon adsorption of the Type 1 polio virus from a secondary effluent showed a competition for the adsorption sites with the organic matter. Desorption of the polio virus from the carbon was obtained as the adsorption of organic material continued.

2. Removals of up to 99% of the polio virus were obtained by the precipitation of 81 mg/l. of phosphate with calcium. Removals of up to 99.9% of the T2 virus were obtained by the precipitation of 66 mg/l. of aluminum phosphate.

3. Virus removal by activated carbon adsorption from a treated waste water is not a dependable process. Removals by phosphate precipitation would appear reliable and a valuable additional benefit in the removal of phosphate.

Sridharan, N. and G.F. Lee

Phosphorus Studies in Lower Green Bay, Lake Michigan.

JWPCF. 46(4):684-696. April 1974.

Key Words: phosphates, surface water (fresh).

Abstract:

The water and sediment analyses indicated that the Fox River is the major source of phosphorus in the lower Green Bay area. An association of phosphorus with iron was indicated in the dredge and core analyses. The phosphorus release experiments under laboratory conditions suggested an iron-associated release. A mechanism is proposed to explain the phosphorus release under oxic and anoxic conditions. The orthophosphate concentrations in water of lower Green Bay should have dropped to about 0.02 to 0.03 mg P/l when the EPA-State of Wisconsin agreement went into effect. Because these concentrations are two to three times higher than the critical concentrations for excessive algal growth, the algae are not likely to become phosphorus limited despite the reduction of phosphorus input from wastewater sources by 80 percent. Because the water quality problems in lower Green Bay include not only high phosphorus but also high BOD and turbidity, the removal of 80 percent of phosphorus from the wastewater discharged into the tributaries of southern Green Bay will produce little improvement of water quality in the southern part of the Bay. On the other hand, the removal of 80 percent of phosphorus from waste water sources is justified in order to protect Lake Michigan from further water quality deterioration.

Srinath, E.G. and R.C. Loehr.

Ammonia Disorption by Diffused Aeration.

JWPCF. 46(8):1939-1957. August 1974.

Key Words: ammonia, diffused aeration.

Abstract:

The mathematical relationships described in this paper are useful for determining the rates of ammonia desorption under a variety of conditions. Such information is useful in assessing performance of systems in which ammonia is removed either intentionally or unintentionally. In many natural systems, ammonia is lost as a result of other processes. Examples would be losses from aerated biological treatment systems, swift streams, impoundments, aerated odor control systems, and waste storage units.

The rate of diffusion of ammonia from its aqueous solution into a steady flow of air is influenced by pH, temperature, and viscosity, as well as other variables. Implicit in the relationships that have been presented is the assumption that the change in ammonia concentration of a wastewater is caused only by ammonia desorption. A direct application of these relationships to predict ammonia concentrations in the effluents would not be possible in treatment systems in which the organic nitrogen is undergoing rapid transformations, resulting in a steady increase in ammonia concentration of the liquid, while ammonia desorption is also occurring simultaneously. It also would not be possible in systems where simultaneous ammonia desorption and ammonia oxidation are occurring. In such cases, modifications of the relationships should be explored.

Nitrogen balances can now be better evaluated because the equations in this paper permit better estimates of the ammonia lost from artificial and natural aerated systems. With the amount of ammonia volatilized known, one can better estimate its effect on the local environment.

Detailed equations have been developed to determine the ammonia desorption coefficient, K_D, under quiescent and aerated conditions. Other equations were developed to determine the quantity of ammonia lost under a variety

of environmental conditions. All equations were verified in both laboratory and pilot-plant scale experiments. The K_D values determined in these studies ranged from 0.004 to 0.8/hr. depending on process conditions.

Staley, T.E. and R.R. Colwell.

Deoxyribonucleic Acid Reassociation among Members of the Genus Vibrio.

International Journal of Systematic Bacteriology. 23(4): 316-332. October 1973.

Key Words: viruses, Vibro cholerae, surface water (marine).

Abstract:

Although application of deoxyribonucleic acid (DNA) reassociation techniques to the classification of vibrios has only recently been employed and, hence, complete data are unavailable, several generalizations regarding the results of such studies can be made. (i) Vibrio cholerae, V. anguillarum, and V. parahaemolyticus show intraspecies polynucleotide sequence variation from 80 to 100% and interspecies relatedness of approximately 20 to 30%. V. parahaemolyticus shows similar intraspecies variation and interspecies relatedness with V. cholerae and V. anguillarum, but considerably higher (60 to 70%) levels of relatedness to V. alginolyticus. It is not possible, at the present time, to place great reliance on other strain or species relatedness for the vibrios. (ii) Very little or no polynucleotide sequence relationship has been demonstrated between members of the genus Vibrio and the genera Pseudomonas, Aeromonas, Zymomonas, Cytophaga, and Escherichia. (iii) Based on the results of the majority of the reciprocal reactions presented, there appears to be no significant influence of genome size on DNA reassociation determinations within the genus Vibrio. Nonpathogenic marine vibrios constitute a particularly heterogeneous group with, as yet, no well-defined species.

Staley, T.E. and R.R. Colwell.

Polynucleotide Sequence Relationships among Japanese and American Strains of *Vibrio parahaemolyticus*.

Journal of Bacteriology. 114(3):916-927. June 1973.

Key Words: viruses, surface water (marine).

Abstract:
Polynucleotide sequence relationships between two reference *Vibrio parahaemolyticus* strains isolated from Japanese and American gastroenterities patients were investigated by use of P-DNA/DNA reassociation in free solution. In addition, these strains were similarly compared with 22 other strains of estuarine and marine vibrios, including 11 strains previously identified as *V. parahaemolyticus* (2 Japanese, 1 of unknown location, and 8 American strains obtained from diverse geographical locations and sources in North America), 3 strains of *V. alginolyticus*, and 8 of *Vibrio* spp. Deoxyribonucleic acid (DNA) from the Japanese and American gastroenteritis isolates showed high relative levels of intraspecific duplex formation (92 to 93%) when reassociated, reciprocally, at 60 C. Heterologous DNA duplexes exhibited thermal elution midpoint Tm(e) values comparable to those obtained from homologous duplexes (88.0) when thermally eluted from hydroxyapatite, thus indicating high base-pair complementarity. Other V. *parahaemolyticus* strains showed DNA homologies of 85% or greater, with correspondingly high Tm(e) values (86.0 to 88.0) for the heteroduplexes formed. DNA of two of three *V. alginolyticus* strains (ATCC 17749 and 166-70) was 55 to 60% homologous to reference *V. parahaemolyticus* DNA preparations; *Vibrio* sp. strain 5144 (originally classified as *V. parahaemolyticus* biotype 2 and subsequently as *V. alginolyticus* strain 5144) showed only 24 to 26% DNA homology to the same reference DNA. These data provide evidence that Vibrio sp. strain 5144 is genetically distinct from the other *V. alginolyticus* strains used in this study. Three bioluminescent strains thought to be closely related to *V. parahaemolyticus* demonstrated only 24 to 31% DNA homology to the reference *V. parahaemolyticus* DNA. These data firmly establish the existence in some Atlantic and Gulf Coast estuaried of organisms genetically very similar to *V. parahaemolyticus*, the causative agent of "shirasu" food poisoning in Japan.

Standard Methods for the Examination of Water and Wastewater, 13th Edition.

American Public Health Association, Washington, D.C., 1971. 874p.

Abstract:

This reference discusses detailed scientific procedures for virtually every analytical test that is utilized in examining both water and wastewater.

Stander, F.J. and L.R.J. Van Vuuren.

The Reclamation of Potable Water from Wastewater.

JWPCF. 41(3):355-365. March 1969.

Key Words: lead, manganese, copper, zinc, chlorides, nitrates, BOD, COD, effluent characteristics, filtration.

Abstract:

The most recent results of research by the National Institute for Water Research, South African Council for Scientific and Industrial Research with respect to potable water reclamation from humus tank effluent and primarily clarified wastewater are presented.

Experimental results showed that the advanced physical-chemical treatment process described can produce a water of potable quality from the final settling tank (humus tank effluent) and primary clarified wastewater at costs of marginally the same order. The two routes of treatment differ in that the nitrate nitrogen is totally absent when primary clarified wastewater is treated, and when it is clarified to the recarbonation/stabilization stage, treatment of primary clarified wastewater offers the possibility of eliminating double biological filtrated results.

Stanford, G.B. and R. Tuburan.

Morbidity Risk Factors from Spray Irrigation with Treated Wastewaters.

In: Wastewater Use in the Production of Food and Fiber - Proceedings. EPA-660/2-74-041, Robert S. Kerr Environmental Research Laboratory, Ada, Oklahoma, June 1974, pp. 56-64.

Key Words: biological contaminants, ponding/land application, agriculture.

Abstract:

This review of the literature has not yet provided an instance in which satisfactory evidence is given that a disease incident has arisen from using treated sewage products. By treated, it is meant that the evidence provided shows that during the days preceding the incident: the treatment plant was operating within design capacity; that the unit processes in that treatment plant were being operated properly and were functioning properly; and that the effluent quality was within the criteria required. In other words, it is suggested that before an incident can justifiably be attributed to the use of treated waste waters, it must be shown that those wastewaters were being fully and properly treated during the period of time which could have been implicated. Until that has been demonstrated one would be calling in question not the health risks of using these materials, but the effectiveness of the design and the operation of that plant. And that demonstration should not be difficult in the future, even though it may, on occasion, have been so in the past.

Starkey, R.J., Jr., M.E. Kuh, A.E. Binks, and K.K. Jain.

An Investigation of Ion Removal from Water and Wastewater.

General Electric Company, Philadelphia, Pennsylvania, August 1973. 129p. (Available from National Technical Information Service (NTIS) as PB-240 158).

Key Words: phosphates, ammonia, nitrates, nitrites, total dissolved solids, fluorides, chemical treatment, adsorption/ion exchange.

Abstract:

An attempt was made to compare the effectiveness of chlorination and ozonation on the removal of a variety of organic compounds from solutions. Both ozone and chlorine concentrations were measured using the ortho-tolidine-manganese sulfate (OTM) method; concentrations were measured spectrophotometrically, and thin-layer and gas-liquid chromatography were used to evaluate oxidation products and concentrations. Both chlorine and ozone are effective but vary greatly in their activity and specific reactions. Chlorine at 3 times conc. was not effective against amino acid proline, p. dioxane, diphenylamine, guanidine, n-hexane, phenol, and pyridine. Ozone was very destructive to the fatty acids levulinic, linoleic and oleic acids. This explains a part of ozone germicidal activity.

Stasiuk, W.N., Jr., L.J. Hitling, and W.W. Shuster.

Nitrogen Removal by Catalyst-aided Breakpoint Chlorination.

JWPCF. 46(8):1974-1983. August 1974.

Key Words: ammonia, nitrates, chlorination.

Abstract:

1. Ammonia nitrogen removals of 100 percent can be achieved by chlorination followed by activated carbon, although some residual nitrate nitrogen is formed.

2. Detention time before carbon contact need only be seconds after mixing.

3. Carbon contact times of 10 min are sufficient to remove chlorine residuals to less than 1 mg/l for pH 7.9 or less.

4. Partial removals are possible, the amount varying with pH and Cl:N ratio.

5. Chlorine requirements for ammonia removal may be accounted for by multiplying the ammonia nitrogen not converted to nitrate by 7.6, the nitrate nitrogen formed by 20.3, and the trichloramine nitrogen by 15.2.

6. Nitrogen was identified as the only gaseous end product of the reaction.

7. The significant breakpoint reaction itself requires a Cl:N ratio of 7.6:1. Higher ratios are caused by the formation of nitrate and trichloramine.

8. It is suggested that the breakpoint chlorination reaction is catalyzed by activated carbon.

"State of the Art" Review of Health Aspects of Wastewater Reclamation for Groundwater Recharge.

State of California Water Resources Control Board, Sacramento, November 1975. 240p.

Key Word: epidemiology.

Abstract:

Wastewater contaminants and their effect on public health are extensively reviewed. The contaminants include biological contaminants (bacteria, parasites, viruses, indicator organisms, dose-response considerations) and chemical contaminants (organic, inorganic, low-level effects, antagonism and synergism).

Steer, A.G., J.H. Nell, and S.G. Wiechers.

A Modification of the Allen and Ridley Technique for the Recovery of _Ascaris lumbricoides_ Ova from Municipal Compost.

Water Research. _8_:851-853. 1974.

Key Word: epidemiology.

Abstract:

The Allen and Ridley method for the isolation of parasitic ova from sewage sludge was modified by the addition on an anionic detergent to an increased test sample. This method was equally efficient for counting _Ascaris lumbricoides_ ova in raw sludge and in various mixtures of sludge and compost. The modified method yielded considerably higher counts for all samples studied than the original method.

Stern, G.

Pasteurization of Liquid Digested Sludge.

Proceedings of the National Conference on Municipal Sludge Management, pp. 163-169. June 11-13, 1974.

Key Words: viruses, bacteria, parasitic worms, protozoa, salmonella, Escherichia coli, coliforms, mycobacterium, heat treatment, effluent characteristics.

Abstract:

1. Pasteurizing at 70°C (158°F) for 30 to 60 minutes destroys pathogens in digested liquid sludge.

2. Sufficient methane gas is produced by anaerobic digestion for the fuel needed to pasteurize digested liquid sludge.

3. Direct steam injection is more efficient than indirect heat transfer for pasteurizing liquid sludge.

4. Thick, unstirred sludge pockets must be avoided for effective pasteurization.

5. Small treatment plants can pasteurize liquid digested sludge at reasonable costs.

6. After pasteurization, liquid sludge needs to be cooled to only 60°C (140°F) before it is sprayed on grass.

Stevenson, A.H.

Bathing Water Quality and Health. III: Coastal Water.

Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, 1976. 145p. (Available from National Technical Information Service (NTIS) as PB-215 332).

Key Words: epidemiology, surface water (marine).

Abstract:
This article discusses the correlation between illness incidence and bathing in waters of a particular bacterial quality. There was 100 percent higher illness incidence in the group under 10 years of age than for those over 10 years of age. Eye, ear, nose, and throat ailments represent more than half of the overall illness incidence.

Stevenson, F.J. and M.S. Ardakani.

Organic Matter Reactions Involving Micronutrients in Soils.

In: Micronutrients in Agriculture. R.C. Dinauer, ed.
Soil Science Society of America, Madison, Wisconsin, 1972.
pp. 79-114.

Key Words: iron, manganese, zinc, copper, boron, ponding/ land application, land reclamation.

Abstract:

The relationship between micronutrients and organic constituents in soil is essentially an unexplored area of soil science. Organic substances play a significant role in the solution and transport of metal ions to plant roots but practically nothing is known of the compounds involved or of the factors affecting their synthesis and destruction under natural soil conditions. It is well known that organic colloids function as a "sink" for metal ions, but very little information is available regarding the proportion of the micronutrients in soil that occurs in insoluble combinations with organic matter or of the factors affecting the availability of the bound nutrients to plants and microorganisms. The need for accurate and reliable methods for determining stability constants of metal complexes with humic and fulvic acids requires little elaboration.

There can be little doubt but that the reactions of micronutrients in soil will never be fully understood until more is known concerning the structures of humic and fulvic acids. Other deserving areas of research include the competitive reaction between organic matter and clay for metal ions, as well as between soluble and insoluble organic ligands. Finally, the biodynamic nature of micronutrient transformations requires more diligent attention.

Stewart, B.A., F.G. Viets, Jr., G.L. Hutchinson, and W.D. Kemper.

Nitrate and Other Water Pollutants under Fields and Feedlots.

Environmental Science and Technology. 1(9):736-739.
September 1967.

Key Words: nitrates, ammonia, groundwater.

Abstract:

Data presented show that nitrate is moving through the soil and into the ground water supply under both feedlots and irrigated fields in crops, excluding alfalfa. Although much larger amounts of nitrate are present under feedlots per unit area, indications are that irrigated lands are contributing more total nitrate to the ground water. The ratio of irrigated land to that in feedlots for the study area is approximately 200 to 1. Feedlots, however, are usually located near the homestead and may have a pronounced effect on the water quality from domestic wells. The findings that water under feedlots frequently contained ammonium (or a compound releasing ammonium) and organic carbon, and had a very offensive odor cause further concern about the effect of feedlots on underground water supplies.

Stobbe, H. and R. Stieglitz.

Fundamental Remarks on the Problem of Occupationally Caused Leukemias.

Pesticide Abstracts. 75-0812. 1975.

Key Words: viruses, epidemiology.

Abstract:

Etiological factors involved in the genesis of preleukemic states and occupational leukemia, and outlines of the mechanism of action of leukemogenic agents are reviewed. Drugs and chemicals causing aplastic anemia (pamyelophthisis) include such preparations as chloramphenicol, acetolamides, methylphenylhydantoin, phenylbutazone, gold preparations, thyrostatic drugs, and benzene as well as pesticides such as organochlorine compounds (DDT, lindane), and organophosphorus compounds in inhalatory or cutaneous exposure. Exogenous leukemogenic agents such as pesticides are considered to be contributory etiological factors which activate a latent leukemia virus in the corresponding cells.

Stone, R.

Sewage Treatment System Odors and Air Pollutants.

Journal of the Sanitary Engineering Division, ASCE. 96 (SA4):905-909. August 1970.

Key Words: bacteria, air.

Abstract:

Odors and air pollutants can no longer be accepted as satisfactory parts of normal sewerage collection and treatment systems. Odor can be controlled by:

(1) Waste pre-treatment at the point of generation;

(2) good sewer and plant design;

(3) good sewer and plant maintenance;

(4) enclosure of facilities;

(5) positive methods for removal of odors by ventilation systems;

(6) odor treatment by activated carbon adsorption; and

(7) other chemical treatment by biochemical, chemical or combustion methodologies. Different air pollutants such as particulate matter can be reduced by appropriate absorption or mechnical equipment.

Stone, R. and H. Smallwood.

Intermedia Aspects of Air and Water Pollution Control.

Ralph Stone and Company, Los Angeles, California, 1973. 368p. (Available from National Technical Information Service (NTIS) as PB-224 812).

Key Words: synthetic/organics, phosphates, nitrates, heavy metals, viruses, bacteria, surface water (fresh).

Abstract:

This publication gives the basic information for intermedia transfer from municipal treatment plant systems.

Stoveken, J. and T. Sproston.

Ozone and Chlorine Degradation of Wastewater Pollutants.

University of Vermont, Burlington, Water Resources Research Center, June 1974. 8p. (Available from National Technical Information Service (NTIS) as PB-238 365).

Key Words: synthetic/organics, chlorination, ozonation.

Abstract:

Three standardized techniques (capillary membrane dialysis, alumina adsorption, alum/polyelectrolyte coagulation) have been compared under laboratory conditions to determine their relative effectiveness in removing a broad spectrum of nutrients, cations, and anions from freshly collected samples of stream water and wastewater effluent (secondary and tertiary). Of these alumina adsorption was highly effective in removal of phosphorus, inorganic carbon, as well as most cations with concomitant reduction of specific conductance and hardness. High Kjeldahl and ammonia nitrogen removal efficiencies of alumina were only observed in samples of wastewater in which pre-treatment concentrations were relatively high. Dialysis occupied an intermediate position in respect to cation removal but produced results equivalent to alumina adsorption in respect to inorganic carbon. Superiority of dialysis in removal of sodium, potassium, chloride, nitrate-nitrite, boron, and dissolved solids is reported. Alum/polyelectrolyte (Betz no. 1150) proved to be effective in removing phosphorus from all waters tested, but was highly ineffective in respect to all other parameters tested.

Stover, E.L. and D.F. Kincannon.

One- Versus Two-Stage Nitrification in the Activated Sludge Process.

JWPCF. 48(4):645-651. April 1976.

Key Words: ammonia, COD, total organic carbon, nitrates, nitrites, activated sludge, filtration.

Abstract:

Acceptable nitrification may be achieved by both the one- and two-stage processes. Each process has its own advantages and disadvantages, and these must be considered when one is making a final decision on which process to select.

Stover, R.C., L.E. Sommers, and D.J. Silviera.

Evaluation of Metals in Wastewater Sludge.

JWPCF. 48(9):2165-2175. September 1976.

Key Words: lead, copper, zinc, cadmium, nickel.

Abstract:

The results obtained from the fractionation of Pb, Cu, Zn, Cd, and Ni in wastewater sludge indicate that sludges contain a wide variety of sites capable of metal retention. Retention mechanisms include ion exchange, sorption, chelation, and precipitation. Metal retention was found to be highly variable, depending on the chemical properties of sludge and on the nature of the metal in question. Based on the authors' data obtained from the proposed procedure for fractionating metals by sequential extractions, the ranking of different forms of Cu, Zn, Pb, Cd, and Ni in wastewater sludge is as follows:

Cu: sulfides > carbonates > organic bound = adsorbed > exchangeable

Zn: organic bound > carbonates > sulfides > adsorbed > exchangeable

Pb: carbonates > organic bound > sulfides > adsorbed exchangeable

Ni: carbonates > organic bound > exchangeable > adsorbed > sulfides

Cd: carbonates > sulfides > organic bound > adsorbed = exchangeable.

Stringer, R. and C.W. Krusé.

Amoebic Cysticidal Properties of Halogens in Water.

Journal of the Sanitary Engineering Division, ASCE.
97(SA6):801-811. December 1971.

Key Words: protozoa, chlorination, iodine treatment.

Abstract:

A new bioassay was developed for the purpose of measuring the amoebic cysticidal properties of concentrations of iodine and free and combined chlorine. The bioassay system was based on a direct enumeration of surviving cysts, as determined by the ability of the amoeba to excyst, leaving behind an easily recognized empty cyst wall. The technique reports survival in percent of total cysts exposed, which, when corrected for control gives valid data for studying the dynamics of disinfection.

The results of these experiments have practical applications in two areas: 1) in public water treatment facilities, the evidence shows that cysts are not likely to survive where prechlorination to a free residual is practiced; 2) disinfection alone should not be relied upon for amoebic cyst kill in small volumes of drinking water for temporary or emergency situations. Iodide would be the cysticide of choice; the globaline tablet which is buffered to lower the pH of iodine-water solution, is the best emergency disinfectant for small canteen volume supplies.

Stringer, R. and C.W. Kruse.

Amoebic Cysticidal Properties of Halogens in Water.

Journal of the Environmental Engineering Division, ASCE.
99(EE2):156-159. April 1977.

Key Words: viruses, protozoa, iodine treatment.

Abstract:

This article is a discussion of the effect on pH of cyst and virus inactivation in iodine systems.

Stukenberg, J.R.

Biological-Chemical Wastewater Treatment.

JWPCF. 43(9):1791-1806. September 1971.

Key Words: BOD, phosphates, activated sludge, chemical treatment.

Abstract:

A combination HRAS-lime coagulation process was tested in the laboratory and in the field for approximately 1 yr. Success of the system depended principally on success of the biological system, as competence in much of the overall process has already been developed. When operating on an average raw wastewater BOD of approximately 140 mg/l, with 2.5 hr aeration, HRAS followed by lime coagulation produced an average effluent BOD of 4.3 mg/l. Should the HRAS-lime coagulation system follow primary treatment, an effluent quality of 4 mg/l BOD may be expected to result from influent BOD as great as 230 mg/l.

The basic need for the HRAS-chemical coagulation of wastewater is threefold: (a) to provide an effluent quality superior to conventional secondary effluent in terms of organic and nutrient removal, (b) to insure consistent effluent quality, and (c) to provide treatment at a cost less than that of conventional tertiary treatment. Pilot data and preliminary cost estimates confirm the ability of HRAS-lime coagulation to fill these needs. Study of the HRAS system on a field pilot scale demonstrated the ability of HRAS to produce a low soluble BOD effluent with aeration detention as low as 1.5 hr. In addition, the HRAS system proved to be unaffected by hydraulic or organic surges, and successful operation was not dependent on the settleability of the mixed liquor. Moreover, the total oxygen demand of the system was similar to that of conventional activated sludge systems.

Wasting of excess biological sludge in the effluent of the HRAS was found to be compatible with the chemical coagulation step, thus reducing the number of waste sludge streams to be handled later. Chemical coagulation with lime was demonstrated to be relatively independent of HRAS effluent SS, phosphate, and color content of the effluent. Moreover, recalcining and recycling of the lime sludge seemed to be advantageous to the settling and thickening properties of the sludge.

The merits of the HRAS-lime coagulation include: (a) relatively high effluent quality with moderate cost; (b) stability of operation with a minimum BOD reduction of 70 per-

cent guaranteed by the chemical coagulation step alone; (c) comparatively simple operation; (d) flexibility in that straight chemical treatment or biological-chemical treatment may be selected with a further option of adding activated carbon adsorption, and (e) HRAS chemical coagulation, when applied to an existing activated sludge plant, makes maximum and economical use of existing facilities.

Stukenberg, J.R.

Physical-Chemical Wastewater Treatment Using a Coagulation-Adsorption Process.

JWPCF. 47(2):338-353. February 1975.

Key Words: BOD, COD, suspended solids, chemical treatment.

Abstract:

A physical-chemical treatment process was developed for the treatment of wastes unsuited for biological treatment. The process consists of the simultaneous chemical coagulation of wastewater and the contacting of the wastewater with powdered activated carbon. In the development of the process, the effect of pH and the possible interference of SS with activated carbon adsorption efficiency were investigated.

The powdered activated carbon adsorption efficiency was found to be essentially the same at the pH values established by alum and lime coagulation.(6.0 to 6.5 for alum and 10.5 to 11.0 for lime). The maximum carbon adsorption efficiency was observed at a pH value of 4.0. The SS present in domestic wastewater and those resulting from the coagulation process did not seem to affect the carbon adsorption efficiency.

The efficiency of the physical-chemical treatment process when it was applied to domestic wastewater was determined from a series of jar test studies followed by pilot plant studies. The jar tests indicated that as much as 96 percent BOD removal and 98 percent COD removal could be accomplished by the treatment process. The results from the operation of a 10-gpm (0.631-l/sec) pilot unit indicated that the combined coagulation-adsorption process could accomplish a 78 percent reduction of raw wastewater COD, whereas coagulation alone could accomplish only 60 percent COD removal. Operation of a 60-gpm (3.786-l/sec) unit with lime and carbon reduced the BOD and COD concentrations of raw wastewater by 86 and 88 percent, respectively. The SS reduction averaged 95 percent. The results from operating the unit with alum and carbon were 91.5 and 92 percent reductions of BOD and COD, respectively. The SS removal averaged 98 percent.

The 60-gpm (3.786-l/sec) pilot plant design was adopted for the production of packaged physical-chemical treatment plants ranging in size from 12,000 gpd (45.4 cu m/day) to 75,000 gpd (283.9 cu m/day). Jar tests conducted during the operation of the pilot plant indicated that the performance of the treatment process could be predicted by jar test

analysis of the wastewater. The coagulant dosage may be determined by a procedure similar to the determination of a carbon adsorption isotherm.

Although the treatment plant design was proven capable of operating with a carbon dosage of 600 mg/l, a practical upper limit of carbon dosage is closer to 300 mg/l. The adsorption efficiency of the powdered carbon was found to approach a maximum value of 0.13 mg COD removed/mg carbon.

Carbon dosages in excess of 300 mg/l accomplished little additional BOD and COD removal. In addition, the cost of powdered carbon does not favor its excessive use. The cost of carbon alone at a 300 mg/l dosage rate is $0.09 to $0.21/1,000 gal ($0.02 to $0.06/cu m) treated.

Waste sludge resulting from the process, whether operated with alum and carbon or lime and carbon, was found to thicken to 3 to 6 percent solids concentration within 6 hr of gravity settling. Operation of the treatment plant with lime and carbon resulted in approximately 12-hr filter runs and a backwash wastewater volume equal to 5 percent of the influent flow. Operation with alum and carbon resulted in 8-hr filter runs and a backwash wastewater volume equal to 7.5 percent of the influent flow.

Stumm, W. and J.J. Morgan.

Aquatic Chemistry: an Introduction Emphasizing Chemical Equilibria in Natural Waters.

Wiley-Interscience, New York. 1970. 583p.

Key Words: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, germanium, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thorium, tin, uranium, zinc, surface water (fresh), surface water (marine).

Abstract:

This is a reference book on aquatic chemistry.

Stumm-Zollinger, E. and G.M. Fair.

Biodegradation of Steroid Hormones.

JWPCF. 37(11):1506-1510. November 1965.

Key Words: synthetic/organics, direct contact, surface water (fresh).

Abstract:

Steroid hormones generally find their way into wastewaters and with them into natural surface and underground waters through urine. Under North American conditions, their normal concentration in municipal wastewaters is expected to be small; under periurban and advanced rural conditions, concentrations well may be doubled and in more primitive rural situations (pit privies and shallow wells) concentrations may become relatively high.

Neverthless, it is our responsibility to learn in what amounts steroid hormones may occur in our drinking waters under the most unfavorable conditions. To this purpose, we must find out to what extent, if any, the steroid hormones are biodegradable in the normal history of wastewaters and receiving bodies of water that may eventually supply drinking water to households.

The preliminary tests described in this paper suggest that estrogens appear to be biodegraded completely but at a slow rate at microbial densities similar to those in activated sludge, and in the presence of additional sources of carbon (nutrient broth, for example).

Sturm, M. and N.N. Hatch.

The Sarasota Phosphate Removal Project.

Water and Sewage Works. 121(3):39-40, 42-43, 59. March 1974.

Key Words: phosphates, activated sludge, chemical treatment.

Abstract:

A phosphate removal system was developed for the City of Sarasota, Florida to treat an average wastewater flow of 7 mgd at an average phosphate concentration of 10 mg/l (PO_4-P). The system consisted of chemical-biological treatment using copperas to precipitate the phosphate, and a polyelectrolyte as a coagulation aid and sludge conditioner. Good phosphate removal was achieved using a proportional iron feed and keeping the MLSS in the aeration tanks around 2500 mg/l.

Sullivan, D.L.

Wastewater for Golf Course Irrigation.

Water and Sewage Works. 117(5):153-158. May 1970.

Key Words: BOD, nitrates, phosphates, viruses, drinking and recreational water.

Abstract:
This paper is a general discussion on the transmission of pathogens by secondary reuse of wastewater.

Sullivan, R.H.

Problems of Combined Sewer Facilities and Overflows.

JWPCF. 41(1):113-121. January 1969.

Key Words: combined municipal and/or storm system.

Abstract:

The survey defined the extent of the combined sewer problem in terms of population and area served, and documented local conditions which bear on the pollution from combined sewer overflows. Research also has been conducted to determine sources of pollution of storm water discharges.

The problems of untreated or inadequately treated sanitary wastewater and industrial wastes still exist and should be given prompt attention. However, if the total problem is considered, controlling and/or treating secondary sources of pollution such as combined sewer overflows and storm water discharges also must be planned. Sewer separation cannot be recommended as the only method of handling the combined sewer overflow problem. Solution of the pollution problem will come only as each jurisdiction evaluates its local situation and determines the combination of methods which will result in the desired level of pollution reduction at the lowest possible cost, the least disruption to the economy, and convenience of urban existence. No easy, inexpensive answers are available.

Summers, W.K. and Z. Spiegel.

Ground Water Pollution: A Bibliography.

Ann Arbor Science Publishers, Ann Arbor, Michigan. 1975. 94p.

Key Words: nitrates, viruses, pesticides, herbicides,
groundwater, direct contact (air).

Abstract:

This partially annotated bibliography is the product of a concentrated literature search particularly in the areas of ground water contamination by nitrates, heavy metals, pesticides and herbicides. The impact of urbanization and the effects of solid waste disposal, animal wastes and petroleum products on ground water quality are covered in the more than 400 entries.

Suñer, J. and J. Piñol.

Coliform Bacteriophages and Marine Water Contamination.

Advances in Water Pollution Research. 1966(3):105-120.

Key Words: bacteria, Escherichia coli, surface water (marine).

Abstract:

The seawater surrounding the beaches and port of Barcelona is highly contaminated by bacteria of fecal origin because the sewage outfalls of the city discharge directly into the sea at those points. The discharges provoke and constantly maintain the pollution.

The contamination is noteworthy all along the beaches. It appears not only close to the shore but also well into the sea over an extensive area. It extends so far that in order to obtain a sample of relatively clean seawater one must go at least 6 km from the shore.

The contamination is indicated as a result of the counts made of the total bacteria capable of growing in conventional culture medium placed in an oven at 37°C and a reading taken at 24 hr, and of using the more significant method of counting the E. coli, which is a species of undoubted fecal origin. These were the direct methods used to make a quantitative determination of the bacteria as mentioned in this paper.

On the other hand, it was decided to examine the presence of bacteriophages of the coliform group in the contaminated seawater as other investigators have done. This has given positive and possibly important results. The sensitive bacterium used for the detection of the bacteriophages was a strain of E. coli called C-5 obtained from the contaminated seawater. This strain of E. coli is found constantly in samples of water taken in the sewage outfalls as well as in the seawater surrounding the beaches and in the Port.

The strain C-5 is not the most plentiful in the sewage water discharges but it always is found there. On the other hand, it does seem to be the predominant strain to be found in the contaminated seawater, and this predominance increases as examination is made at points farther from the mouths of the outfalls. It is not pathogenic and it may be manipulated quite easily and simply for this reason. Besides this, the C-5 strain is highly

sensitive to the action of the group bacteriophages, giving zones of complete lysis or confluent lysis and easy to read on nutritive agar plates.

From the qualitative point of view these experiments seem to show that the discovery of bacterial contamination of water by the indirect method of determining the specific bacteriophages might be in itself of great utility in giving an index. However, the tests carried out thus far seem to indicate that, while this indirect method would not be very useful in the search for such an easily detected species as _E. coli_, it would be sufficiently effective in the case of a study of pathogenic species that are difficult to isolate, such as salmonella.

On the other hand, the quantitative determinations obtained from parallel examination of _E. coli_ and group bacteriophages have provided results that the authors accept as satisfactory and even, in some cases, as unforeseen. First, in all samples of water containing _E. coli_, the presence of bacteriophages of its group has been detected. Second, the absence of _E. coli_ in other samples has coincided with an absence of bacteriophages.

This fact could be explained if the sensitive species used for the detection of the bacteriophages were lysogenic, but several tests made with strain C-5 gave a negative result. It has not been possible for the authors to show the existence of lysogenia and prophages in this strain. Accordingly, there must be some other explanation which remains unknown at present.

Finally, there is one other point which should be noted and which was unexpected, namely, the numerical relationship between the _E. coli_ and the bacteriophages in the contaminated seawater. In nearly all the samples, the _E. coli_ count and that of the bacteriophages gave almost the same figures or, at least, very similar figures. This fact does not seem to fit in with the theory, and yet the number of samples of water examined is so great that the authors feel that it is not a mere coincidence.

Susag, R.H.

BOD Reduction by Chlorination.

JWPCF. 40(11):R434-R444. November 1968.

Key Words: BOD, COD, chlorination.

Abstract:
This article discusses BOD removal by chlorination.

Sutherland, J.C., J.H. Cooley, D.G. Neary, and D.H. Yuri.

Irrigation of Trees and Crops with Sewage Stabilization Pond Effluent in Southern Michigan.

In: Wastewater Use in the Production of Food and Fiber - Proceedings. EPA-660/2-74-041, Robert S. Kerr Environmental Research Laboratory, Ada, Oklahoma, June 1974. pp. 295-313.

Key Words: ammonia, nitrates, phosphates, crops, ponding/land application.

Abstract:

Corn in droughty, infertile soil showed excellent response to irrigation with stabilized sewage wastewater.

The use of pond stabilized sewage wastewater for irrigation of hardwood and conifer plantings in southern Michigan produced several distinct results after two years of treatment.

The use of wastewater for the irrigation of hardwood cuttings and seedlings produced considerable increases in survival and height growth.

Sutton, P.M.

Efficacy of Biological Nitrification.

JWPCF. 47(11):2665-2673. November 1975.

Key Words: bacteria, nitrification/denitrification.

Abstract:

From the results obtained in this investigation, it may be inferred that:

1. Under pseudo steady-state condition, separate and combined sludge systems operated for carbon removal and nitrification of a municipal wastewater will remove equal amounts of filterable total Kjeldahl nitrogen at equal system SRT's;

2. Nitrification in combined sludge systems, under steady flow conditions, is independent of the mixing regime or reactor configuration;

3. The nitrification rate is more temperature sensitive than the rates for organic removal. In both combined and separate sludge systems, the temperature sensitivity decreases with increasing SRT. In a separate sludge system, in order to achieve complete nitrification at temperatures approaching 5°C, a minimum system SRT of 10 days is necessary; and

4. The addition of inorganic chemicals to a nitrifying activated sludge plant at dosages that achieved 1 mg/l effluent total phosphorus concentrations seems to have no detrimental effect on the nitrification rate.

Sutton, P.M., K.L. Murphy, B.E. Jank, and B.A. Monoghan.

Efficacy of Biological Nitrification.

Presented at the 47th Annual Conference of the Water Pollution Control Federation, Denver, Colorado, October 1974. 25p.

Key Words: ammonia, phosphates, nitrification/denitrification, chemical treatment, activated sludge.

Abstract:

One phase of an intensive biological nitrification/denitrification pilot plant program being conducted at the Wastewater Technology Centre, Burlington, Ontario, included the evaluation of combined sludge and separate sludge, carbon removal-nitrification systems for treatment of municipal waste water. The specific alternative systems compared were:

1. single-stage combined,
2. two-stage combined, and
3. two-stage separate sludge systems.

Parallel reactor systems provided a sensitive assessment of any two alternatives during each experimental run. Variable speed feed pumps and a temperature controller allowed the reactors to be operated over a range of loading conditions and temperatures.

In each alternative, the degree of nitrification achieved was found to be dependent on the sludge age or solids retention time (SRT) of the system. At equal system sludge ages, little difference in ammonium removal was evident when the separate sludge alternative was compared with the combined sludge alternatives. In each system, the nitrification rate was found to be more temperature sensitive than the rates for organic carbon removal particularly at lower temperatures. In order to achieve complete nitrification at temperatures approaching 5°C, a minimum system SRT of 10 days appears necessary regardless of the alternative selected.

In addition to the combined and separate sludge comparative study, the effects on nitrification of chemical addition for phosphorus removal were determined through operation of a 20 Igpm extended aeration pilot plant. Chemical addition included alum and ferric chloride. No detrimental effect on nitrification was evident at chemical addition rates successful at achieving over 90%, total phosphorous removal.

Sutton, P.M., K.L. Murphy, and R.N. Dawson.

Low-Temperature Biological Denitrification of Wastewater.

JWPCF. 47(1):122-134. January 1975.

Key Words: suspended solids, nitrates, nitrites, nitrification/denitrification.

Abstract:

The principal purpose of the study was to determine the rate of denitrification under various conditions of loading and temperature in order to ascertain the practicality of the biological denitrification process. This was accomplished by using an experimental design at five levels of temperature and two levels of sludge age in the stirred tank reactor. With the packed columns, five detention times were used. This design meant that continuous operating data could not be obtained over extended periods at any given set of operating conditions.

The results of the pilot plant study indicate the feasibility of biological denitrification even at temperatures as low as 5°C with either a packed column or a stirred tank system. Previous studies by Dawson and Murphy indicated that denitrification effectively ceased at 3°C.

Sutton, P.M., K.L. Murphy, and B.E. Jank.

Nitrogen Control: A Basis for Design with Activated Sludge Systems.

Presented at the Conference on Nitrogen as a Water Pollutant, Copenhagen, Denmark, August 1975. 16p.

Key Words: ammonia, nitrates, nitrites, activated sludge, nitrification/denitrification.

Abstract:
With both nitrification and denitrification processes, nitrogen incorporated in the suspended solids decreased the overall nitrogen removal capability.

Suzuki, T., T. Mirjama, and C. Toyama.

The Chemical Form and Bodily Distribution of Mercury in Marine Fish.

Bulletin of Environmental Contamination and Toxicology.
10:347-355. October 1973.

Key Words: mercury, fish.

Abstract:

This paper discusses various forms of mercury (organic and inorganic) and the bodily distribution thereof and provides criticism of existing data. Findings include the fact that the biological concentration of mercury by the muscle is related to organic mercury and the extent of concentration is not large. Biological concentration in liver and kidneys (both inorganic and organic mercury) is remarkably dominant.

Swanson, C.L., R.E. Wing, W.M. Doane, and C.R. Russell.

Mercury Removal from Waste Water with Starch Zanthate-Cationic Polymer Complex.

Environmental Science and Technology. 7:614-619. July 1973.

Key Words: mercury, chemical treatment.

Abstract:

Sequential addition of starch xanthate and a cationic polymer [e.g., poly(vinylbenzyltrimethylammonium chloride) or polyethylenimine]to a mercury (II) solution precipitates both polymers and the mercury as a cohesive floc that is easily removed by filtration. Some xanthate groups on the starch backbone may form mercury (II) salts while others react with the polycation to form a polyelectrolyte complex. The amount of xanthate required to precipitate the cationic polymer and mercury is determined by streaming current measurement. Effectiveness of mercury removal depends on the ratios of mercury, cationic polymer, and xanthate. Residual mercury concentrations were as low as 3.8 μg/l after single treatment of solutions that had initial mercury (II) concentrations of 1.0×10^5 μg/l.

Removal of mercury(II) ion from waste water by treatment with xanthates of simple alcohols has been proposed. Researchers found that $(ROCS_2)_2 - Hg^2 +$ precipitates when the mercury(II) concentration is less than that of the xanthate, but if the mercury(II) concentration is greater, the soluble $[(ROCS_2) - Hg^{2+}]^+$ species is formed. Starch xanthate is known to precipitate zinc(II) and other heavy metals.

Swets, D.H., L. Pratt, and C.C. Metcalf.

Thermal Sludge Conditioning in Kalamazoo, Michigan.

JWPCF. 46(3):575-581. March 1974.

Key Words: ammonia, phosphates, heat treatment.

Abstract:

The City of Kalamazoo is well pleased with its new sludge treatment facility and is confident that it will continue to do an efficient and effective job of handling the sludge production. Thermal conditioning of sludge, particularly with partial oxidation as a part of the process, producing a sterile end product, has significant advantages that will dictate its broader utilization. The historic, readily upset anaerobic sludge digestion process will no doubt be replaced by thermal conditioning, particularly in communities that have diverse industrial wastes.

The economic advantages of thermal sludge conditioning over chemical conditioning were proven using sludge from a rather complex and unique waste treatment system.

Swisher, R.D., T.A. Taulli, and E.J. Malec.

Biodegradation of NTA Metal Chelates in River Water.

In: Trace Metals and Metal-Organic Interactions in Natural Waters. P.C. Singer, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1974. pp. 237-263.

Key Words: cadmium, copper, iron, mercury, manganese, nickel, lead, zinc, surface water (fresh).

Abstract:
The present experiments show that a variety of NTA metal chelates are biodegradable in river water at environmentally realistic concentrations, confirming and supplementing the results of other workers. Thus, there is no reason to expect that NTA chelates would accumulate in the environment even if extensive amounts of NTA were used in detergent formulations.

Switzer, R.W. and J.B. Evans.

Evaluation of Selective Media for Enumeration of Group 70 Streptococci in Bovine Feces.

Applied Microbiology. 28(6):1086-1087. 1975.

Key Words: fecal streptococci, bacteria, crops, livestock.

Abstract:

Streptococci may be the most numerous fecal bacteria capable of aerobic growth, substantially outnumbering the coliform bacteria (in feces). The relative sizes of the populations of 3 species of Streptococcus may have diagnostic value in identifying sources of fecal pollution, but studies of the occurrence and distribution of these species in the feces of the different animals and in habitats or products that are subject to fecal contamination are hampered by poor recovery values on the media commonly used. Several types of selecting media were evaluated by the membrane filter technique. Enterococcosel broth seemed to be the most suitable media tested for enumerating streptococci from bovine feces. This conclusion may be applicable as well to mammalian feces, but not necessarily to food and sewage.

Talbot, P. and R.H. Harris.

The Implications of Cancer-Causing Substances in Mississippi River Water.

Environmental Defense Fund, Washington, D.C., November 1974. 49p.

Key Words: surface water (fresh), drinking and recreational water, chlorination.

Abstract:

The Mississippi River rises in Minnesota and flows southward 2350 miles to the Gulf of Mexico, draining over 40% of the United States and part of Canada. Including its numerous tributaries, such as the Ohio River, it is the receptacle for a wide variety of municipal and industrial wastes. Many of the industries, including the petroleum, organic chemical, and coal-products industries, are known to discharge persistent carcinogens into the Mississippi River. In addition, chlorination of water during treatment increases the carcinogenic burden. Consequently, these carcinogens are imbibed by millions of Americans, as has been documented recently by the Environmental Protection Agency during studies on eight cities that receive drinking water from the Mississippi River system. In Louisiana alone, over one million people are served water from the lower Mississippi River or its distributaries. Presumptive epidemiological evidence accumulated by the Environmental Defense Fund with the aid of a computer-assisted statistical model suggests a significant relationship between cancer mortality among white males and drinking water obtained from the Mississippi River. Neither the Environmental Protection Agency nor state and local regulatory agencies have to date developed adequate programs of pollution abatement or drinking water treatment to address these problems, despite the availability of inexpensive and effective remedial measures.

Tamura, O. and S. Mitsui.

Relationship Between Consumption of Pesticides and Chronological Changes in Myopia in School Children in Tokushima Prefecture.

Pesticides Abstracts. 75-1893. 1975.

Key Words: organophosphorus pesticides, epidemiology.

Abstract:
The result of a statistical and epidemiologic investigation on the relationship between the chronological change in use of organophosphorus insecticides and the recent increase in incidence of myopia in school children in Tokushima Prefecture was described. The incidence of myopia was studied based on the data from 1957 to 1973, excluding 1970, on about 40,000 children from primary and middle schools. Even for children of the same age there was a great difference in the degree of increase in the morbidity, especially high in 1958, 1963, 1969, and 1972, and thereafter the morbidity was low in several consecutive years. In the year following any year when larger amounts of organophosphorus insecticides were consumed the morbidity from myopia in school children showed a rapid increase and vice versa. Based on these findings and a report that organophosphorus pesticide intoxication could possibly cause myopia, it is considered that the recent increase in myopia in school children was due, at least to a certain extent, to chronic intoxication of organophosphorus insecticides.

Tanaka, Y., H. Frank, and H.F. DeLuca.

Methylmercury as Percentage of Total Mercury in Flesh and Viscera of Salmon and Sea Trout of Various Ages.

Science. 181:567-568. August 1973.

Key Words: mercury, fish.

Abstract:

The proportion of methylmercury to total mercury in the flesh of salmon (*Salmo salar*) 1 to 7 years old and sea trout (*Salmo ocla*) 1 and 2 years old was found to average 93 percent with a range of 81 to 98 percent, and to be independent of the age of the fish. In salmon and sea trout 1 and 2 years old, methylmercury constituted 26 to 67 percent of the total visceral mercury, without age dependence.

Tang, N.H.

Relationship Between BOD Removal and LAS Detergent Removal.

University of Puerto Rico, Mayaguez, Water Resources Research Institute, May 1974. 68 p. (Available from National Technical Information Service (NTIS) as PB-232 997).

Key Words: BOD, activated sludge, trickling filter.

Abstract:
Traditionally, biological process efficiency is measured by its BOD removal. However, a period of 5 days is required to determine the BOD in wastewater. In detergent, LAS (Linear Alkylate Sulfonate) is a basic organic element which is readily degraded in municipal biological processes. The fact that LAS can be rapidly determined within 30 minutes makes its use advantageous for process control. The results of the study indicate that BOD removal and LAS removal in both, activated sludge and trickling filter processes are significantly correlated. It is very likely that the % LAS removal of a biological process can be used to predict the % BOD removal of the same process.

Tanner, F.W.

Public Health Significance of Sewage Sludge When Used as a Fertilizer.

Sewage Works Journal. 7:611-617. 1935.

Key Words: mycobacterium, crops.

Abstract:

Longevity of pathogenic bacteria in soil is influenced by different factors. Among the important ones are character of the strain used, hydrogen-ion concentration of the soil, nature of competing bacteria, amount of moisture, penetration of light and air and others. Sufficient data have been recorded in the literature to justify the conclusion that polluted soil may infect vegetables grown on it. Whether the problem is serious, however, depends on many factors. Any material, therefore, which may contribute pathogenic bacteria to soil becomes of considerable sanitary significance. Sewage sludge is in this category, because sewage from which it comes is known to contain pathogenic bacteria.

That sewage sludge should be applied with considerable caution to land on which crops to be eaten raw are to be grown has been recognized for many years. One researcher, however, stated that if it is held in a sludge digestion tank for a period of not less than 10 days, its application to soil may be practiced without detriment to public health through the possible dissemination of vegetable-borne diseases. He suggested regulations that would prevent delivery to farmers of sludge which has been digested for less than 10 days. He further suggested that the sludge should be used on ground only before crops are planted and not sprinkled over or brought into direct contact with growing vegetables. The origin of and the type of the sludge undoubtedly has considerable bearing on the results which may be secured. Whether the conclusions would apply to all types of sludge could be determined only by comprehensive investigations. New methods for isolating bacteria have been developed in the past few years. Use of these methods might reveal the presence of bacteria where the older methods gave negative results. A recent paper would suggest that it is now time for more work on the subject.

Isolation of Bacterium typhosum from activated sludge has been reported. Investigations of artificially inoculated aeration mixtures were then made. Five and one-half hours aeration caused a decrease in viable

Bacterium typhosum cells from 750,000 to 103,000 per ce. Four strains of Bacterium typhosum were used in experiments on longevity in activated sludge. At 68° to 72°F, one of the strains died rapidly; two others survived for from 8 to 10 days; the fourth, the Rawling's strain, was isolated after 14 and 13 days. It was concluded that wet activated sludge cannot be considered innocuous. At times it may be quite infectious. Caution should be observed when it is used as a fertilizer for truck gardens.

The application of sewage sludge to soil on which vegetables which may be eaten raw are grown, should be practiced with caution. While results of longevity studies on pathogenic bacteria in sludge would probably be greatly influenced by the nature of the sludge and the conditions under which it is stored and handled, sufficient data have been recorded to indicate the presence of viable Bacterium typhosum cells in sludge. At best, the sludge should be added to the soil in the late fall, winter or early spring. Advice is probably sound that it should not be added to growing crops. Sanitary districts and others concerned with the sale of sewage sludge to farmers might well consider the possible health hazards involved.

Tardiff, R.G. and M. Deinzer.

Toxicity of Organic Compounds in Drinking Water.

In: Proceedings of 15th Water Quality Conference, Champaign Illinois, February 1973. pp. 23-32.

Key Words: synthetic/organics, drinking and recreational water.

Abstract:

Organic compounds which have been identified from finished drinking water are classified as to their degree of toxicity, and the organs affected by them are listed. The article discusses the reasons for and means for identifying and studying organics in drinking water.

Tatsumoto, M. and C.C. Patterson.

Concentrations of Common Lead in Some Atlantic and
Mediterranean Waters and in Snow.

Nature. 199(4891):350-352. July 27, 1963.

Key Words: lead, surface water (marine).

Abstract:

The concentration profiles of lead in the Atlantic were found to be different from those in the Mediterranean and the Pacific. At the Mediterranean and Pacific stations, lead concentrations are high in surface waters and uniformly low in deeper waters. At the Atlantic stations the concentrations do not follow such a uniform trend with depth, and, in addition, the scatter is confined to considerably smaller values. However, in general, lead concentrations at the Atlantic stations appear to increase from surface to intermediate or deep waters, and then decrease again in very deep or bottom waters.

Taylor, D.G. and J.D. Johnson.

Kinetics of Viral Inactivation by Bromine.

In: Chemistry of Water Supply, Treatment, and Distribution. A.J. Rubin, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1975. pp. 369-408.

Key Words: viruses, bromide disinfection.

Abstract:

The aqueous bromine system offers a unique opportunity to study five chemical species as biocides at one pH. The study of individual species is not possible with the chlorine or iodine systems at a constant pH. The chemical species hypobromous acid, molecular bromine and nitrogen tribromide were tested at pH 4.5 for their virucidal activity and compared to the activity of hypochlorous acid against the bacterial virus ØX174.

Bromine was studied as an alternative to chlorine because bromine does not ionize at neutral pH, has more desirable characteristics as a swimming pool disinfectant, and is active even in the form of bromamine. Chloramines, on the other hand, possess little virucidal activity.

Although the economics of bromine was not a part of this study, bromine cost limitations on its use cannot be ignored. Bromine is presently twice the cost of chlorine. The use of bromine chloride to generate free bromine in water is feasible at a lower cost. Bromine chloride may be fed and metered as a gas at low pressure rather than as a liquid and, therefore, promises to be easier to dose than liquid bromine. Moreover, since hypobromous acid is only ionized 6 percent at pH 7.6, as compared to the 50 percent ionization of hypochlorous acid, only about one-half of the amount of bromine is required to achieve the same effective molar concentration of active halogen at that pH.

Taylor, D.H. and G.D. Hutchinson.

Evaluation of State Drinking Water Quality Surveillance Programs.

JAWWA. 67(8):428-431. August 1975.

Key Word: drinking and recreational water.

Abstract:

Water-supply practice was found deficient in all four states as were the state programs, designed to ensure adequate quantities of safe drinking water to the public. This conclusion is not reassuring.

State legislatures, the administrative levels of state government, and the water-supply field need to make more vigorous commitments to restore and broaden the margins of safety that water supplies provide in the southeast U.S. Provision of safe, adequate water supplies will depend upon universal application of higher water-utility service standards and vigorous regulations, surveillance, and enforcement by public environmental control agencies.

Taylor, F.B.

Viruses - What Is Their Significance in Water Supplies?

JAWWA. 66(5):306-311. May 1974.

Key Words: viruses, coliforms, hepatitis virus, ECHO virus, coxsackie virus, polio virus, surface water (fresh).

Abstract:

The largest waterborne outbreak of modern times was in Delhi, India, in 1955 when over 30,000 cases of infectious hepatitis were recorded. Transmission was through a municipal water-supply system. It must be recognized that the source of water at the time was nearly undiluted sewage from an upstream source. However, in more recent times (1969), there was the Holy Cross episode in which 94 cases of infectious hepatitis were incurred by a population segment in excellent health who drank water from a community supply that had been contaminated through a cross connection.

At President Johnson's Water-for-Peace Conference in 1967, a paper was presented by Dr. L. Coin of the Laboratoire D'Hygiene de la Ville de Paris, France, on his work in examining samples of water from the rivers upstream and downstream of Paris and from the Paris distribution networks and the sewage effluents from hospitals. It summarized an earlier paper wherein he reported finding 9 percent of the distribution system samples (553) positive for such viruses as polio, virus Types I, II, and III, Coxsackie and ECHO, in contrast to 17 percent in the upstream rivers, 24 percent in the downstream rivers, and 37 percent in the sewage discharged from a hospital. The Seine River is a source of Paris's water supply. He concluded that poliomyelitis virus had hurdled the technical barriers consisting of coagulation, filtration, and disinfection, which is by the use of ozone, but he doubted that it had an epidemiological role.

Tchobanoglous, G.

Filtration Techniques in Tertiary Treatment.

JWPCF. 42(4):604-623. April 1970.

Key Words: chlorides, nitrates, phosphates, filtration.

Abstract:

Conclusions derived from studies designed to evaluate filter bed performance include:

1. The removal efficiency for the filtration of settled secondary effluent without the addition of chemicals is primarily a function of grain size. Typical removal efficiencies using conventional single medium sand or anthracite filter beds with depths of 18 to 30 in. (45.7 to 76.2 cm) will vary, depending on grain size,from 10 to 60 percent.

2. In the filtration of a settled effluent with and without the additional chemicals, turbidity breakthroughs were not observed within the headloss range studied {8 to 10 ft (2.4 to 3.0 m)}.

3. As presently designed, the sand layer in most dual medium (anthracite and sand) filter beds is not utilized effectively. In multi-media filter beds, if the anthracite layer is greater than 16 to 20 in. (41 to 51 cm), media placed below the anthracite contributes little to the overall suspended solids removal.

4. Polyelectrolytes can be used as an additive to achieve varying degrees of suspended solids removal from secondary effluents using single-, dual-, and multi-media filter beds. The distribution of the suspended solids removed within a filter bed can be controlled by varying the amount and point of addition of polyelectrolytes.

Tchobanoglous, G. and R. Eliassen.

Filtration of Treated Sewage Effluent.

Journal of the Sanitary Engineering Division, ASCE. 96(SA2): 264. April 1970.

Key Words: suspended solids, pressure filtration.

Abstract:

Effluent used in this investigation was obtained from a pilot scale activated sludge treatment plant. Particulate matter in the effluent was characterized by measurement of suspended solids, particle size and distribution, and particle charge and charge distribution. The suspended solids concentration in the effluent varied between 7 mg per l and 14 mg per l. Particles in the effluent were bimodally distributed. The smaller range of particles varied in aerial size from 1 μ to 15 μ while the larger range of particles varied in size from 50 μ to 180 μ. The average electrophoretic mobility of the particles was -1.5 μ per sec per v per cm.

Although a number of removal mechanisms are operative, straining was found to be the principal mechanism responsible for the removal of particulate matter. Removal by straining can be detected by noting the shape and variation of the suspended solids removal curves and from a plot of headloss versus time.

The size and distribution of the influent particles, their floc strength, the size of the medium, the filtration rate, and the amount of material arrested within the filter must be considered in the development of equations which can be used to describe the time-space removal of particulate matter within a granular filter. Derived from rational considerations, equations were developed to predict filter performance, as a function of these variables for the conditions studied. The equations can also be generalized for cases where straining is not the principal removal mechanism.

Tenney, M.W., W.F. Echelberger, Jr., J.J. Coffey, and
T.J. McAloon.

Chemical Conditioning of Biological Sludges for Vacuum Filtration.

JWPCF. 42(2):R1-R21. February 1970.

Key Words: suspended solids, vacuum filters.

Abstract:

Although properly operating activated sludge processes develop well-flocculated sludge through the biological production of polymeric flocculants, these naturally produced materials are not at all effective as conditioners of waste sludge for dewatering by vacuum filtration. It is, therefore, necessary to add chemical conditioners such as the polyvalent metal ions Al(III) and Fe(III) or synthetic organic polyelectrolytes (cationic, nonionic, or anionic) in order to structure properly the waste activated sludge for successful dewatering. The action of polyvalent metal ions and synthetic organic polyelectrolytes as sludge conditioners is interpreted as being similar to the action of the microbially produced polymers which serve biologically to flocculate activated sludge. In order to be effective a chemical conditioner must be capable of forming polymeric species which are capable of attaching themselves to the otherwise discrete sludge particles and subsequently bridging to other individual particles, thereby conditioning the sludge so that, in the presence of a vacuum, it has sufficient structure or porosity to allow for the effectual escape of water. From this laboratory study, it is concluded that the carriage wastewater quality parameters of pH, alkalinity, and phosphate concentration, and the sludge parameters of solids concentration, storage time, and primary sludge mix ratio all significantly affect the conditioner dosage required to enhance the dewatering of waste activated sludge.

It is also quite apparent that individual applications of the investigative areas described in this study are necessary for the development of an optimal chemical conditioning process to insure effective dewatering of waste activated sludge by vacuum filtration at specific wastewater treatment locations.

Tew, R.W., S.S. Egdorf, and J.E. Deacon.

Distribution of Stream Pollution in Lake Water.

JWPCF. 48(5):867-871. May 1976.

Key Words: bacteria, surface water (fresh).

Abstract:

Wastewater effluent-laden waters from Las Vegas Wash (LVW) form a density current that may be detected in Boulder Basin of Lake Mead at considerable distances from the wash estuary. This led to the suspicion that water from the inflowing stream {40 mgd (1.5 x 10^5 cu m/day)} might not be rapidly diluted in the enormous volume of the lake {19 mil acre-ft (2.3 x 10^{10} cu m)} , but might persist as a recognizable entity to the vicinity of the intake of a major water source for populous Clark County, Nev.

The data indicate that bacteria appearing sporadically in an inflowing stream (already there) may be used to trace the distribution of the waters of the stream in those of a lake and that the use of a factorial sampling and assay experimental plan allows compliance with Precepts 1 and 2 given above.

Theis, T.L. and P.C. Singer.

The Stabilization of Ferrous Iron by Organic Compounds in Natural Waters.

In: Trace Metals and Metal-Organic Interactions in Natural Waters. P.C. Singer, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1974. pp. 303-320.

Key Words: iron, surface water (fresh), surface water (marine).

Abstract:

This study has demonstrated that organic matter is capable of creating conditions whereby the oxidation of ferrous iron in well-oxygenated environments is inhibited. Humic substances, as represented by the model compounds used in this investigation, can stabilize ferrous iron through the formation of Fe(II)-organic complexes which resist oxidation or through reduction of the resultant ferric iron by the organic species. The stability of iron in many natural aquatic systems can create specific problems in water supply and wastewater treatment, and may be nutritionally significant with respect to aquatic growth.

Thimann, K.V.

Herbicides in Vietnam.

Science. 185(4147):207. July 19, 1974.

Key Words: herbicides, epidemiology.

Abstract:

The findings of the National Academy of Sciences Committee in their report on the Effects of Herbicides in Vietnam are defended in a Letter-to-the-Editor. There was no evidence that birth defects could be attributed to the spraying in the records of the Vietnamese hospitals examined. There was no evidence of the persistence of herbicide residues in the soil of any of the sprayed areas. There was no medical evidence to support claims that any Montagnard children had died from the spraying. The claim that the mangroves in the coastal areas will not regenerate for 100 yr because of herbicides is without foundation. Mangrove swamps have never before been killed by herbicides over large areas.

Thomas, R.E.

Land Disposal II: An Overview of Treatment Methods.

JWPCF. 45(7):1476-1484. July 1973.

Key Words: ponding/land application.

Abstract:

This overview has touched on several aspects of a topic that has been debated for centuries. Case histories and the results of research studies have been used to show that (a) land treatment of wastewater is not new, (b) land treatment is a significant tool in past and current management of wastewaters, (c) use of land treatment is evolving from a disposal concept to a concept of treatment and/or reuse, and (d) land treatment methods can play a significant role in future wastewater management plans. Land treatment has been proffered as a method of protecting the quality of surface waters since mankind started collecting waste for disposal. The case is still undecided, and it seems that the debate will be continued into the 21st century.

Thomas, R. E.

The Soil as a Physical Filter.

In: Conference on Recycling Treated Municipal Wastewater through Forest and Cropland. W.E. Sopper and L.T. Kardos, eds. EPA-660/2-74-003. Pennsylvania State University, University Park, Institute of Research on Land and Water Resources, March 1974. pp. 40-46.

Key Words: BOD, ponding/land application, agricultural sludge disposal.

Abstract:

In summary, the research efforts directed to identifying the causes of soil clogging elucidated three important factors to consider in selecting management practices for applying wastewater to the land. These three factors are (1) the zone of clogging which reduces the water intake rate is at or near the soil surface; (2) the most severe clogging develops in an anaerobic environment; and (3) the severe clogging developed under anaerobic conditions can be removed by drying the clogged surface layer of soil. Further studies of these three factors under practical operating conditions have verified the results of the small scale research studies.

Looking at crop irrigation systems, we find that good operating practices preclude the development of anaerobic conditions leading to formation of the troublesome clogging mat. Physical clogging of the filter for the irrigation approach should be limited to deposition of small amounts of suspended mineral particles and slowly degradable organic particles. The effects of these additions appear to go unnoticed at locations where wastewater irrigation has been practiced for up to 80 years. Quantitative information on differences in soil properties after 14 years of wastewater irrigation versus a fresh water irrigation source led to the conclusion that wastewater irrigation did not result in adverse effects that could not be corrected with minor changes in cultural practices. The adverse differences in soil properties observed in this study were associated with chemical interactions rather than physical clogging by deposition.

The situation is entirely different when one considers spray disposal and groundwater recharge approaches where the desire for high rates of hydraulic loading frequently lead to moisture conditions which promote development of anaerobic conditions and the consequent severe clogging of the soil filter. This situation

has been counteracted by developing a routine management practice of alternating wetting periods and drying periods to take advantage of the fact that drying of the clogged surface results in recovery of the capacity to move water. The periodicity of the wetting and drying cycle can vary from a few days to a few weeks depending on local conditions and the overall objectives of a given project. Much remains to be learned in this area for improvement of techniques but we can make practical use of current knowledge, and some recharge operations have been in operation for several decades.

This brief discussion of the soil as a physical filter has been directed to factors which lead to clogging of the filter and management practices which can be used to extend the life of the filter. These aspects of the behavior of the filter are closely related to the chemical, biological, and hydrogeological interactions which are covered in companion papers presented during the symposium. Reference to these companion papers will strengthen and broaden one's understanding of the function of the soil as a filter for receiving municipal effluents or industrial wastewaters.

Thomas, R.E. and T.W. Bendixen.

Degradation of Wastewater Organics in Soil.

JWPCF. 41(5):808-813. May 1969.

Key Words: ammonia, COD, BOD, chlorides, suspended solids, direct contact.

Abstract:
The results of these lysimeter studies show that soil microorganisms can digest much of the organic carbon contained in primary and secondary wastewater effluents. About 80 percent of the organic carbon from septic tank effluent was digested under a variety of conditions. Large variations in temperature, the loading rate, and the duration of dosing had no effect on the percentage of the organic carbon which was degraded. Organic carbon application rates up to 31 tons/yr/acre (157 metric tons/yr/ha) resulted in soil residues of less than 3 tons/yr/acre (6.7 metric tons/yr/ha). A loading rate of 3.7 tons/yr/acre (8.3 metric tons/yr/ha) resulted in a net reduction in the organic carbon content of a silt-loam soil. CO_2 equivalent to about 60 percent of the degraded organic carbon was released at the soil surface in one experiment.

Sludge loadings equivalent to 30 tons/yr/acre (67 metric tons/yr/ha) of organic carbon can be applied to sandy soils for extended periods without resulting in a detrimental accumulation of organic residues in the soil. Based on typical values for the composition of sludge, this would be equal to 100 tons/yr/acre (224 metric tons/yr/ha) of dried digested sludge solids.

Proper management of liquid and organic carbon loads can result in long-term continuous operation with only minor changes in the organic carbon content of the soil.

Future studies are planned to evaluate the interaction between loading factors and the alteration of the physical and chemical properties of the soil.

Thomas, R.E. and J.P. Law, Jr.

Soil Response to Sewage Effluent Irrigation.

In: Municipal Sewage Effluent for Irrigation. C.W. Wilson and F.E. Beckett, eds. Agricultural Engineering Department Symposium, Louisiana Polytechnic Institute, Ruston, Louisiana, July 30, 1968. pp. 5-19.

Key Word: groundwater.

Abstract:

Recent emphasis on water pollution control has stimulated research on the application of wastewaters to the land. About two-thirds of the more than 1,300 systems in operation were designed for treatment of a wastewater rather than irrigation of economic crops. A variety of needs and empirical solutions have resulted in the evolution of several system designs. Each of these designs have advantages for particular operating conditions and needs. Some wastewaters are unsuitable for irrigation use because of the addition of toxic or excessive concentrations of pollutants during the use cycle. Many industrial and most domestic wastewaters are suitable for irrigation use under good management practices. Wastewater can cause beneficial or detrimental changes in physical and chemical properties of soil. Good management practices and system design features can make the beneficial effects greater than the detrimental effects. Wastewaters receive treatment as they percolate through soil. Systems can be designed and operated to accentuate this treatment. The resulting soil percolate is immediately suitable for many reuse purposes.

Thomas, R.E., K. Jackson, and L. Penrod.

Feasibility of Overland Flow for Treatment of Raw Domestic Wastewater.

Robert S. Kerr Environmental Research Laboratory, Ada, Oklahoma, December 1974. 39p. (Available from National Technical Information Service (NTIS) as PB-238 926).

Key Words: suspended solids, BOD, COD, ammonia, nitrates, ponding/land application, groundwater.

Abstract:
A pilot-scale field study was conducted to evaluate the capability of overland flow to provide complete treatment of raw comminuted wastewater on a year-round basis in a mild climatic zone. Raw comminuted wastewater was applied through a specially designed distribution system which operated at low pressure and prevented the formation of aerosols. This specially designed applicator operated at a pressure of 1.0 kg/sq cm (15 psi) and was used to apply wastewater to three experimental plots at 7.4, 8.6, and 9.8 cm/week rates of loading. Wastewater and plot runoff samples were collected periodically to compare treatment efficiencies for the three loading rates and to determine seasonal influences on treatment efficiency. Fifteen parameters including suspended solids, biochemical oxygen demand, nitrogen, and phosphorus were used to evaluate treatment efficiencies. The results of this 18-month field study showed overland flow to be an effective process for achieving advanced waste treatment of raw comminuted wastewater via a simple system with no sludge production.

Thomas, R.L.

The Distribution of Mercury in the Sediments of Lake Ontario.

Canadian Journal of Earth Sciences. 9(6):636-651. June 1972.

Key Words: mercury, surface water (fresh).

Abstract:

Total mercury has been analysed in the surface 3 cm of sediment taken from 287 sample stations on an 8 km grid on Lake Ontario during 1968. The mercury distribution shows well-defined trends which can be related to sediment type: the concentration of mercury increasing from the shallow nearshore coarse sediments outwards, into the central, deep-water basin sediments composed of fine silty clays and clays. The average concentration of mercury in the nearshore sediments is 355 ppb, in the basin sediments 997 ppb and the average for the whole lake is 651 ppb. Regions of high mercury concentration (in the order of 2000 ppb) occur along the southern margin of the main lake basin and in the western (Niagara) basin of the lake. The dispersion pathways of these two regions point to the Niagara River as the prime source of mercury input to Lake Ontario. Most of this mercury is believed to be of industrial origin. An additional area of high mercury concentration with values up to 20,000 ppb, occurs at the eastern end of Lake Ontario (Kingston Basin) in the region of the lake close to the outlet to the St. Lawrence River. These high values in organic-rich, fine sediments are likely related to processes of biological concentration. The concentrations of mercury observed in the recent sediments of Lake Ontario can be accounted for by an average minimum daily input of 125 lb (56.7 kg) of mercury of which an estimated 42 lb (19.0 kg) is of natural origin and the remaining 83 lb (37.6 kg) is from industrial sources. The vertical distribution of mercury in a selected sediment core suggests that industrial mercury input commenced about the turn of the century, rose rapidly to circa 1943 and, since then, has shown a slow but continued rise to the time of core retrieval in 1970.

Thomas, R.L.

The Distribution of Mercury in the Surficial Sediments of Lake Huron.

Canadian Journal of Earth Sciences. 10(2):194-204. February 1973.

Key Words: mercury, surface water (fresh).

Abstract:

Total mercury has been determined in 163 samples of the topmost 3 cm of sediment taken from Lake Huron during 1969. Total mercury values range from 54 to 805 ppb with a mean of 222 ppb and a standard deviation of 162 ppb. The mercury distribution in the lake sediments shows a trend for increasing concentration from nearshore and mid-lake shallow water, coarse sediment deposits outwards into the fine-grained sediments in the deeper water basins. The application of a quartz correction to compensate for the dilution by an inert constituent reveals two major anomalies of higher mercury concentration. The Saginaw anomaly occurs in the southern basins of the lake and is believed to be due to the input of industrial mercury from Saginaw Bay; the Bruce anomaly in the northeastern part of Manitoulin basin is believed to be due to the weathering of sulfide deposits with subsequent concentration in the lake sediments being related to major water circulation patterns in the lake. From statistical analysis the mercury is believed to be bound in the sediments predominantly adsorbed or complexed by organic matter with subsidiary adsorption by the surfaces of iron sulfides and hydrated iron oxide - inorganic phosphorus complexes.

Thompson, S.E., C.A. Burton, D.J. Quinn, and Y.C. Ng.

Concentration Factors of Chemical Elements in Edible Aquatic Organisms.

University of California, Lawrence Livermore Laboratory, October 1972. 77p. (Available from National Technical Information Service (NTIS) as UCRL-50564).

Key Words: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, germanium, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thorium, tin, uranium, zinc, surface water (fresh), surface water (marine), fish, shellfish.

Abstract:
This revision of the identically titled document presents tables of concentration factors derived for edible plants, invertebrates, and fish from both freshwater and marine environments. The values are based on an extensive literature review of elemental concentrations in aquatic organisms and water and on experimentally determined concentration factors. The document also summarizes concentration factors for edible plants, molluscs, crustaceans, and fish derived from studies on radioactivity in the environment.

The Appendix gives the basic data used to derive the concentration factors and the special procedures employed to estimate concentrations or concentration factors where the required data were inadequate or nonexistent.

Thorne, M.D., T.D. Hinesly, and R.L. Jones.

Utilization of Sewage Sludge on Agricultural Land.

University of Illinois, Champaign, April 1975. 8p.

Key Words: nitrates, phosphates, shigella, fecal streptococci, clostridium botulinium, leptospirosis, listeria monocytogens, agriculture.

Abstract:
This paper discusses crop response to sewage sludge, but does not attack the problem of uptake by plants.

Thorup, R.T., F.P. Nixon, D.F. Wentworth, and O.J. Sproul.

Virus Removal by Coagulation with Polyelectrolytes.

JAWWA. 62(2):97-101. February 1970.

Key Words: *Escherichia coli*, polio virus, chemical treatment.

Abstract:

1. Under the experimental conditions, the cationic polyelectrolyte performed more acceptably than the anionic and nonionic types.

2. The action of polyelectrolytes as primary coagulants was salt dependent with both high (0.1 M), and low (0.0001 M) ionic concentrations producing less virus removal than the 36 percent found with 0.01 M $CaCl_2$.

3. In instances of poor coagulation, cationic polyelectrolytes exerted a beneficial effect on the formation of flocs and the removal of virus. However, the 80-94 percent virus removal obtained was well below the 99+ percent usually considered acceptable.

4. In instances of adequate coagulation, cationic polyelectrolytes did not increase virus removal beyond the levels obtained with unaided $Al_2(SO_4)_3$ or $Fe_2(SO_4)_3$ coagulation.

Three Summary Tables Relating to Metals Removal.

Dallas Water Utilities Water Reclamation Research
Center, Dallas, Texas, September 1975.

Key Words: aluminum, arsenic, boron, barium, cadmium, cobalt, chromium, copper, iron, mercury, manganese, nickel, lead, selenium, zinc, chemical treatment, adsorption/ion exchange.

Abstract:

This is a personnel communication giving data on metals removal.

Tiedje, J.M. and B.B. Mason.

Biodegration of Nitrilotriacetate (NTA) in Soils.

Soil Science Proceedings. 38:278-283. March 1974.

Key Words: synthetic/organics, groundwater.

Abstract:

Nitrilotriacetate (NTA) was biodegraded in a variety of soils as measured by total CO_2 and $^{14}CO_2$ production from ^{14}C-carboxyl-NTA. Production of CO_2 and $^{14}CO_2$, followed similar patterns and suggested complete degradation of NTA; $^{14}CO_2$ production was used routinely to assay NTA dissimilation. At 40 ppm of NTA in soils receiving sewage effluent and in muck soils, maximum rates of degradation were 8 to 10 ppm/day while in mineral surface soils, they ranged from 0.5 to 6 ppm/day; the rates in subsoils were always less than for the surface soils from the same site. Degradation rates did not correlate with pH, drainage, texture, or plant cover. Rates of degradation increased from 2 to 64 ppm/day as NTA concentration was increased from 10 to 600 ppm. $^{14}CO_2$ production from NTA did not occur anaerobically and was severely limited under microaerophilic conditions. NTA was degraded at 24 and 12.5 C; it was also degraded at 2 C if previously acclimatized at 12.5 C. Iminodiacetate was a possible intermediate in NTA degradation, while N-methyliminodiacetate was not.

Tiffin, L.O.

Translocation of Micronutrients in Plants.

In: Micronutrients in Agriculture. R.C. Dinauer, ed. Soil Science Society of America, Madison, Wisconsin, 1972. pp. 199-209.

Key Words: iron, manganese, zinc, copper, boron, ponding/land application, land reclamation.

Abstract:

Micronutrients in the living plant pass through many phases. Some of them appear transiently; others are relatively permanent. Phases involved in the passage of a micronutrient to the xylem are not well defined, but they are easily separated from long-distance movements. The translocation of micronutrients necessarily represents an interphase; it follows and depends on uptake and precedes assimilation and function or, perhaps, storage in distant tissues. Much more information is needed concerning the quantity as well as the form and and direction of micronutrients moving between tissues.

Similar aspects of micronutrient translocation appear in animal studies, and the available knowledge is impressive. Examples relate to Fe and Cr in transferrin, Cu in ceruloplasmin, and Mn in transmanganin, as well as the small molecules that apparently shuttle metals between large circulating molecules and the tissues. Less is known about specific mechanisms of micronutrient translocation in plants, but the pattern now emerging indicates that they do not use large protein molecules to transport metals over long distances. Apparently the small ubiquitous molecules such as organic and amino acids perform this function. An effort should be made to identify Cu, Zn, and Ni carriers in xylem fluids.

Despite many studies of metal-phosphate interactions in plants, current knowledge in this field is unsatisfactory in terms of explicit information and relevance for agriculture. There is a need for further knowledge relating to (i) the external solution chemistry and, if obtainable, the internal chemistry associated with metal phosphate precipitation; (ii) the chemical composition

of metal phosphate precipitates *in vivo*; and (iii) the physiological effects of metal phosphate precipitation in terms of reduced yields and resulting economic loss.

Experiments should be designed in terms of controlled concentrations of P, Fe, Zn, Ca, H^+, OH^-, and other ions that affect or are affected by P both in uptake and translocation phases. The organic and amino acids also should be considered because of their expected effects on equilibria between mobile and immobile phases of metals *in vivo*. In the vascular system, these acids probably constitute a major defense against Fe^{3+} inactivation by OH^- and P.

Progress in metal detection and analysis and nutrient ion control should help in making increasingly refined determinations of metals both on external surfaces and in vascular tissues. A large-volume, circulating system in which concentrations of nutrient ions and H^+ are controlled has been described. This system should be especially useful in defining external conditions that immobilize metals internally.

The nutrient ions should be kept agriculturally relevant. A comparison, for example, of 1,000 μM P, often used in standard nutrient compositions, with 1 μM P continuously available to roots in flowing culture provides an important contrast in method and perspective. The use of extremely nonphysiological treatments, e.g., very high P or other ions, should obligate an investigator to establish that such usage has relevance to situations occurring naturally or likely to occur under some conditions of fertilizer practice. Incisive tests for relevance could obviate some of the phosphate-poisoning experiments.

Instruments that permit direct microsampling of vascular fluids should make it possible to intercept metals flowing in xylem vessels. In addition to solution sampling, the X-ray microanalyzer offers promise as a means of detecting quantities of phosphate on walls in the lumen of the xylem. One researcher describes the use of this instrument in studies of metal distribution in plant cells, and others have described the localization of Al, N, Ca, and P in cortex cells of barley and bean roots by X-ray microanalysis.

The ability to detect Al within the cell protoplast (apparently soluble, chelated) and not precipitated in cell walls with Ca or P suggests possibilities for studies of other elements.

The time a micronutrient stays in a leaf may be relatively long compared to its translocation time. But at certain stages of growth a fraction of a micronutrient may again be mobilized and translocated to other organs. Micronutrients also are released from senescing tissues and are translocated to more permanent structures such as roots and stalks of perennials. The physiological importance of redistribution calls for continued study. Much more work will be needed to establish quantitative patterns of micronutrient redistribution comparable to those available for macronutrients. Beyond this, investigations are needed to identify causes and the various internal and external factors that modify redistribution.

Tilstra, J.R., K.W. Malveg, and W.C. Larson.

Removal of Phosphorus and Nitrogen from Wastewater Effluents by Induced Soil Percolation.

JWPCF. 44(5):796-805. May 1972.

Key Words: ammonia, nitrates, phosphates, ponding/land application.

Abstract:

Municipal wastewater treatment effluents were applied to a field of nearly waterlogged peat soil to determine the effect of a saturated soil environment on the removal of phosphorus and nitrogen from the effluents. Immediately after the application of effluents, phosphorus fixation by the soil declined, whereas nitrogen removal increased. An undetermined amount of organic nitrogen was initially leached from the soil, thus masking the quantitative effects of nitrogen fixation processes.

Drainage was provided to this particular soil in a laboratory experiment to determine the possible effect of an aerobic soil environment (tile draining the field), on the phosphorus and nitrogen removal efficiency of the soil. Phosphorus fixation largely improved, resulting in removal efficiencies ranging from 95 to 99 percent, although severe nitrification and subsequent leaching persisted during the entire experiment. Amendments for controlling the nitrogen problem are suggested.

When saturated (presumably anaerobic) and aerobic soil systems were compared with regard to wastewater effluent phosphorus and nitrogen removal efficiency, the aerobic system seemed to be considerably more advantageous, provided that proper management practices were employed.

Tinsley, T. and J.L. Melnick.

Potential Ecological Hazards of Pesticide Viruses.

Intervirology. 2(3):206-208. 1973/74.

Key Words: viruses, epidemiology.

Abstract:
The use of viruses to control insect pests is being considered as an alternative to chemical pesticides. However, the plan is not without flaws: insects other than the target may be attacked. Reports of a high degree of species-specificity for insect viruses should be viewed with reserve since antibodies reacting with insect viruses have been found in domestic and wild animals, pigs, cattle, sheep, horses, dogs, deer, and in sera of laboratory workers handling insect viruses. Changes in the pathogenicity and specificity of pesticidal insect viruses could occur and cause a wider spectrum of host involvement. Unequivocal systems of virus identification are necessary. However, because of inadequate descriptions of viruses often found in the literature, it is very difficult to determine if a new virus has been isolated or if the virus is merely an extension of the host range of a previously recorded virus. Collaborative research programs on the in vitro specificity of insect viruses are recommended. When it is found that a candidate virus can infect vertebrate cells in vitro, results must be confirmed where possible in vivo.

Tofflemire, T.J. and G.P. Brizner.

Deep-Well Injection of Wastewater.

JWPCF. 43(7):1468-4179. July 1971.

Key Words: suspended solids, bacteria, groundwater.

Abstract:

Deep-well injection is a method of long-term storage or ultimate disposal that should be used only for certain hard-to-treat wastewaters in areas geologically suited for injection. Before deep-well injection is used, it should be determined that this disposal method will have the least adverse effect on the environment of all feasible treatment methods. Three classes of deep wells -- saltwater, industrial waste, and radioactive waste -- were listed.

The most suitable strata for injection are sand, sandstone, or limestone. The disposal stratum must be covered by an impermeable cap rock such as shale, salt, or clay and isolated from any usable water or natural resources. Abandoned wells and faults must be avoided. Several figures showing the possible injection areas in the U.S. and in New York State are indicated.

Liquid hydraulic fracturing should be avoided because it is difficult to know if fractures will travel horizontally or vertically. Vertical fractures could allow wastewater to pass into higher strata and contaminate natural resources. However, grout injection represents a special case.

The waste to be injected should be high in concentration, low in volume, noncorrosive, and free of SS and microorganisms. Tests should be made to insure that the wastewater will not react adversely with the formation water or strata. Equalization and filtration of the wastewater commonly are practiced before injection. Additional treatment may be needed to make the wastewater compatible with the formation.

Either rotary or cable tool methods are used in drilling the well. Bottom hole completion methods include open hole, gravel pack, and perforated casing. Adequate casing, tubing, and cementing are important in well construction. The well

should be monitored carefully for pressure, flow, and other parameters. Disposal zone pressures should generally be limited to 0.8 psi/ft (0.185 km/sq cm/m) of depth and to 75 percent of the critical input pressure. Back-up treatment or storage systems are needed to handle a well shutdown.

Tofflemire, T.J., L.J. Hetling, and W.W. Shuster.

Activated Carbon Adsorption and Polishing of Strong Wastewater.

JWPCF. 45(10):2166-2179. October 1973.

Key Words: COD, suspended solids, BOD, total organic carbon, ammonia, phosphates, total dissolved solids, nitrates, nitrites, coliforms, chemical treatment, influent characteristics, effluent characteristics, chlorination.

Abstract:

Disinfection with chlorine or D3TH. The carbon column effluent had an average coliform count of 3,600,000/100 ml. The addition of 5 to 15 mg/l of chlorine to a 10- to 15-min contact tank following the nitrification reduced the count to 120,000/100 ml. The occasional use of 20 mg/l chlorine did not reduce the count significantly. However, when 1 mg/l of liquid D3TH was fed over a 30-day period the average count was only 11/100 ml. Chlorine reacts readily with H_2S and wastewater organics before it greatly affects the bacteria, while D3TH does not seem to be readily consumed by wastewater organics.

Tong, S.S.C., W.D. Youngs, W.H. Gutenmann, and D.J. Lisk.

Trace Metals In Lake Cayuga Lake Trout (Salvelinus namaycush) in Relation to Age.

Journal of the Fisheries Research Board of Canada. 31:238-239. February 1974.

Key Words: aluminum, antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, germanium, iron, lead, molybdenum, nickel, tin, zinc, fish.

Abstract:

Chromium concentration increased and molybdenum and tin concentrations decreased in Lake Cayuga lake trout from age 1 to 12 yr. The concentration of the rare element rhodium ranged from about 100 to 200 ppb. The concentrations of 33 other trace elements in the fish are reported.

Tornabene, T.G. and H.W. Edwards.

Microbial Uptake of Lead.

Science. 176:1334-1335. June 1972.

Key Words: lead, surface water (fresh).

Abstract:

Micrococcus luteus and Azotobacter sp. cells grown in broth in contact with a dialysis membrane containing lead bromide were found to immobilize 4.9 and $3.1/10^2$ milligrams of lead per gram of whole cells, on a dry weight basis, respectively. Culture turbidity and cell count measurements on these and other cell cultures show that lead bromide, lead iodide, and lead bromochloride in concentrations approaching solubility limits have no detectable effect on overall growth rate and cell viability. Analyses of cellular subfractions reveal that fractions of cell wall plus membrane contain 99.3 and 99.1 percent of the lead found associated with Micrococcus luteus and Azotobacter sp., respectively. The remainder is found associated with the cytoplasmic fractions.

Torpey, W.N., H. Heukelekian, A.J. Kaplovsky, and R. Epstein.

Rotating Discs with Biological Growth Prepare Wastewater for Disposal or Reuse.

JWPCF. 43(11):2181-2188. November 1971.

Key Words: BOD, rotating biological disks.

Abstract:

A method of treatment of primary effluent by a series of rotating disks with attached growths has been developed capable of producing removals of carbonaceous BOD up to 95 percent and the oxidation of ammonia to nitrates. The removal of N and P from the effluent of these units is being attempted by promoting the growth of attached filamentous algae on illuminated rotating disks that are readily harvestable in contrast with the removal of planktonic algae grown in oxidation ponds. The effluent thus prepared is highly amenable to adsorption on activated carbon such that the leakage was held between the limits of 1 to 2 mg/l.

Tossey, D., P.J. Fleming, and R.F. Scott.

Tertiary Treatment by Flocculation and Filtration.

Journal of the Sanitary Engineering Division, ASCE.
96(SA 1):75-90. February 1970.

Key Words: BOD, suspended solids, phosphates, coliforms, chemical treatment, filtration, chlorination.

Abstract:

The number of variables in the wastewater treatment system and the short period of operation covered in this paper make the task of isolating meaningful relationships and drawing final conclusions very difficult. However, for the purpose of reporting progress during the period of time that the project was financed in part by an FWPCA Demonstration Project Grant the following conclusions are offered:

1. Conventional water treatment procedures using coagulation, flocculation, and rapid-sand filtration as a method of tertiary treatment offer the City of Dayton a sound means of achieving a high quality effluent from a trickling filter wastewater treatment plant.

2. A high degree of phosphate removal is achieved with chemical coagulation and settling (without the final polish of rapid-sand filtration).

3. While removal efficiencies for both pilot plant filters are approximately the same, the dual media filter has achieved better overall performance than the single media sand filter.

4. Chemical coagulation and flocculation before final settling offer a flexible means of improving effluent quality significantly when compared to plain settling. Facilities to achieve this improvement are relatively modest in cost. The chemical additions, although costly, may be tailored to fit seasonal needs, flow variations, and unusual demands.

5. A one-step chemical treatment process was not shown to be a substitute for properly operating secondary treatment.

6. The cost of chemical treatment before final settling may approach or even exceed the costs of primary and secondary wastewater treatment.

7. Any scheme for enhancement of the secondary plant

effluent appears to require chemical treatment as a part of the process. Rapid-sand filtration without prior chemical treatment does not appear to offer a sound investment return on capital expenditures.

8. Any scheme of tertiary treatment using chemicals and rapid-sand filtration must be evaluated by considering the total scope (including the problems of sludge handling and backwash water overload). The period of operation of this project has not provided data for comparative evaluation of these factors.

9. Demonstration of any given technique must be programmed over at least a 12-month period in order to verify the methodology over the full range of plant influent and treatment variations.

Trichinosis Surveillance Annual Summary 1975.

U.S. Center for Disease Control, HEW. August 1976.

Key Word: epidemiology.

Abstract:

In 1975, 284 cases of trichinosis were reported in the U.S. The article discusses epimethiologic characteristics, clinical characteristics, and reported outbreaks.

Trump, J.G., K.S. Wright, E.W. Merrill, A.J. Sinskey, D. Shah, and S. Sommer.

Prospects for High Energy Electron Irradiation of Wastewater Liquid Residuals.

Massachusetts Institute of Technology, Cambridge, 1975. 18p.

Key Words: COD, viruses, bacteria, protozoa, radiation treatment.

Abstract:

Powered by a 50 kilowatt electron source, this system will permit the in-line irradiation of selected materials including raw sludge and wastewater over the dosage range 10^5 to 2×10^6 rads. At 4×10^5 rads, the anticipated dosage for adequate disinfection of sludge, the treatment capacity would be 100,000 gal (400 m^3) per day. The two-year program will determine the methods and efficacy of disinfection and oxidation by electrons at these higher flow rates. The influence on biochemical effectiveness and cost of several treatment conditions as irradiation at elevated air and oxygen pressure, homogenization, increased solids content, and controlled ph will be explored. Inactivation of human enteric and other viruses in sludge will be emphasized.

Injected into water the maximum penetration of such electrons is about one centimeter for each 2 million electron-volts of energy. By appropriately irradiating a wide thin band of moving sludge or water with a rapidly scanning electron beam, a nearly uniform ionization dosage can be delivered throughout the material. The electron energy, redistributed among the atoms and molecules of contaminated water, produces the highly reactive free radicals H and OH. These in turn attack entrained molecules to promote their oxidation, reduction, dissociation and degradation. The free radicals may combine to form some active molecules which are themselves useful for water treatment--hydrogen peroxide and ozone. Simultaneously, the ionization exerts a direct lethal effect on microorganisms--on bacteria, viruses, spores, molds, and on larger organisms including algae, protozoa and parasites. These complex reactions are initiated in the small fraction of a second as the material flows through the zone of intense ionization produced by the electron beam. Adequately and properly applied, the resultant chemical and biological effects can convert sludge and wastewater into safely disposable and reusable materials. COD

reduction (- ΔCOD) varies nearly linearly with radiation dose at least up to 1 megarad, even with no dissolved oxygen (i.e. with nitrogen atmosphere equilibration). Data so far accumulated confirms that COD reduction in sludge by electron irradiation is dependent on oxygen availability. It emphasizes the desirability of providing oxygen prior to irradiation to maximize the oxidative reactions initiated by electrons. Other methods, such as foaming, of increasing the oxygen availability during irradiation are being investigated.

Trust, T.J. and K.H. Bartlett.

Occurrence of Potential Pathogens in Water Containing Ornamental Fishes.

Applied Microbiology. 28(1):35-40. July 1974.

Key Words: bacteria, coliforms, epidemiology.

Abstract:

The bacterial population of the water supplied with ornamental fish purchased from retail outlets was examined qualitatively and quantitatively. As many as 10^9 viable aerobic organisms per 100 ml were present, with fecal coliform counts as high as 10^5 per 100 ml. Citrobacter, escherichia, pseudomonas, and vibrio were isolated from 75% or more of the samples, whereas aeromonas, alcaligenes, enterobacter, flavobacterium, and streptococcus were isolated from 45 to 65% of the samples. Pseudomonas aeruginosa, Edwardsiella tarda, and Klebsiella pneumoniae were also isolated.

Tsai, C.

Effects of Sewage Treatment Plant Effluents on Fish:
a Review of Literature.

University of Maryland, College Park, 1975. 236p.

Key Words: ammonia, chlorides, BOD, salmonella, shigella, fecal streptococci, synthetic/organics, food processing, fish.

Abstract:

This article provides a review of literature concerning different parameters of sewage effluents effects upon fish, marine, and estuarine fish.

Tsai, C. and J.A. Tompkins

Survival Time and Lethal Exposure Time for the Blacknose Dace Exposed to Free Chlorine and Chloramine Solutions

University of Maryland, College Park, Water Resources Research Center, 1974. 26p. (Available from National Technical Information Service (NTIS) as PB-239 958).

Key Words: chlorides, synthetic/organics, fish.

Abstract:

The survival time and lethal exposure time were determined by continuous flow bioassay for the blacknose dace, Rhinichthys atratulus, exposed to four concentrations each of free chlorine solutions, 0.15, 0.74, 1.38 and 6.60 mg/liter and of chloramine solutions, 0.19, 0.51, 1.31 and 5.25 mg/liter as total chlorine. The lethal exposure time is shorter than the survival time for the concentrations tested. The difference between the median lethal exposure time and median survival time decreases with a decrease in total chlorine concentrations and becomes similar at the concentration 0.09 mg/liter for the free chlorine solutions and 0.21 mg/liter for the chloramine solutions. Using either the median survival time or median lethal exposure time as the toxicity index, free chlorine is more toxic than chloramines to the blacknose dace at high concentrations, but less so in low concentrations.

Tsernoglou, D. and E.H. Anthony.

Particle Size, Water-Stable Aggregates, and Bacterial Populations in Lake Sediments.

Canadian Journal of Microbiology. 17(2):217-227. February 1971.

Key Words: bacteria, surface water (fresh)

Abstract:

Sediments from 10 lakes for which bacterial counts were available were submitted to particle size analysis (Coulter Counter), both before and after removal of organic material. While these sediments were not so highly aggregated as soils, they contained water-stable aggregates and differed from one another in this characteristic. The counter failed to detect some apparently unstable aggregations visible in the sediment of one lake. The median sizes of the untreated sediment were observed to be inversely proportional to the median sizes of the sediment from which the organic component had been removed. There was good correlation between logarithms of the heterotrophic bacterial population (culture counts) and the median sizes of the particles in untreated samples of the sediment. Estimations of bacterial density, assuming a specific gravity of 1.6 for these sediments indicated that, for the four lakes for which direct counts of bacteria were available, there were from 3000 to 15000 bacteria per square millimeter of sediment particle surface, or about 1 bacterium for every 70 to 300 sq μ.

Tullanair, V.

Final Disposal of Municipal Sludge in Sweden.

JWPCF. 47(4):688-695. April 1975.

Key Words: zinc, copper, manganese, lead, chromium, nickel, cobalt, cadmium, anaerobic digestion.

Abstract:

Sludge handling in Sweden is regulated by a number of laws and edicts, such as the Public Health Act and the Environment Protection Act. This paper is a summary of the most recent instructions from the National Swedish Environment Protection Board.

Turney, W.G.

Mercury Pollution: Michigan's Action Program.

JWPCF. 43(7):1427-1437. July 1971.

Key Words: mercury, epidemiology.

Abstract:

This is a compilation of data on mercury pollution gathered to 1970 and a preliminary assessment of the problem in Michigan. The article also includes the history and clinical symptoms of mercury pollution and poisoning.

Ulmgren, L.

Swedish Experiences in Chemical Treatment of Wastewater.

JWPCF. 47(4):696-703. April 1975.

Key Words: BOD, phosphates, COD, suspended solids, ammonia, nitrates, nitrites, influent characteristics, effluent characteristics, chemical treatment.

Abstract:

The Swedish law governing environmental protection, dated July 1, 1969, directs that all municipal wastewater must be treated at least biologically. A radical reduction of the phosphorus content in wastewater has, however, been given high priority in Sweden. At least a 90 percent reduction is required for inland lakes and smaller rivers; this means that the phosphorus content in the discharged wastewater will be 0.3 to 0.6 g/ cu m as P. The required degree of reduction of organic matter expressed as biochemical oxygen demand (BOD) is decided in each particular case. As a rule, 90 percent reduction will be required, although a 60 percent reduction has been permitted when the receiving water flow is great enough to produce satisfactory dilution.

Generally, it may be said that the cities located on inland waters and in those coastal areas situated on archipelagos must have chemical precipitation. In most cases, this must be combined with biological treatment. Chemical treatment is not only a question of reducing phosphorus and BOD. It also provides for a good reduction in heavy metals (depending on pH), worm eggs, and, in some cases, better nitrogen reduction. Chemical treatment is normally easier and quicker to operate after process disturbances, in comparison with biological treatment. It has also been shown that it is not possible to use biological treatment methods to obtain satisfactory reductions in the northern part of Sweden because of the long winters, which result in extremely low water temperatures. In these cases, chemical treatment for reduction of organic materials (BOD) is used.

Upgrading Existing Wastewater Treatment Plants: Case-Histories.

EPA Technology Transfer, U.S. Environmental Protection
Agency, Washington, D.C., August 1973. 49p.

Key Words: BOD, suspended solids, oil and grease, ammonia, nitrates, coliforms, influent characteristics, effluent characteristics, trickling_filters.

Abstract:

This article discusses case study situations in which existing municioal treatment was upgraded, using a variety of methods.

Upgrading Lagoons.

EPA Technology Transfer, U.S. Environmental Protection Agency, Washington, D.C., August 1973. 43p.

Key Words: BOD, activated sludge, trickling filters.

Abstract:
This article is a general discussion on the use of lagoons for treatment of municipal wastewater.

Urban Runoff Adds to Water Pollution.

Environmental Science and Technology. 3(6):527. June 1969.

Key Words: BOD, surface water (fresh).

Abstract:

In general, APWA finds that urban runoff amounts to 1% of the raw sewage for the particular area. Another way of looking at the magnitude of the pollution potential is that this water pollution potential amounts to 5% of the BOD discharged from the area's secondary waste treatment facilities.

But the water pollution from this urban source occurs only during rainfall or snow thaw. Assuming that a 14-day accumulation of street litter and that all of the soluble BOD in the dust and dirt fraction would be discharged into the street inlets during a 2-hr. storm, APWA estimated that the shock pollution load on receiving waters would be 160% of the raw sewage BOD and 800% of the secondary treatment effluent during the 2-hr. period.

Urie, D.H.

Phosphorus and Nitrate Levels in Groundwater as Related to Irrigation of Jack Pine with Sewage Effluent.

In: Conference on Recycling Treated Municipal Wastewater through Forest and Cropland. W.E. Sopper and L.T. Kardos, eds. EPA-660/2-74-003, Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp. 157-164.

Key Words: nitrates, phosphates, land reclamation.

Abstract:

The single plot test described here illustrated that the nitrates added in sewage effluent irrigation may reach shallow water tables under sand-soil, forest conditions. Phosphorus renovation was complete during the initial year. Public health considerations may limit the permissible dosage levels in such highly permeable soils. Further tests will be needed to determine whether hardwood forest types or shrub-herb cover conditions may be more satisfactory for sewage renovation purposes on sandy/soils. Alternative methods of cropping or volatilization of nitrogen may be a necessary pretreatment before economic volumes of sewage effluents can be renovated satisfactorily. Dilution of nitrate levels during groundwater flow may be a satisfactory solution in remote areas, with small sewage irrigation loads, and where domestic water supplies are protected.

Experience with this single plot test has resulted in the adoption of a different type of field test in locations where sewage effluent must be trucked to the test site. Tests now in progress utilize plots about 0.001 hectare in area using gravity methods of application. Tension lysimeters (soil-water samplers) are being used instead of wells to test the degree of renovation under various treatments. These micro plots do not permit tests of response of large trees to sewage treatments. Replicated tests of renovation are possible with small volumes of effluent on a variety of soils and understory vegetation types.

USEPA Notice of Intent to Issue a Policy Statement on Acceptable Methods for the Utilization or Disposal of Sludge from Publicly-Owned Wastewater Treatment Plants.

Chicago Metropolitan Sanitary District. February 20, 1974.

Key Words: aluminum, cadmium, chromium, copper, iron, manganese, nickel, mercury, zinc, phosphates, chlorides, ammonia, nitrates, nitrites, DDT, aldrin, dieldrin, endrin, chlorinated hydrocarbons, soil sterilants, BOD, suspended solids, total dissolved solids, biological contaminants, surface water (fresh).

Abstract:
This publication is a prelude to specific policy on the methods of wastewater sludge management. Included are potential policies on sludge utilization and disposal, partially based on the sludge contaminant content.

Uthe, J.F. and E.G. Bligh.

Preliminary Survey of Heavy Metal Contamination of Canadian Freshwater Fish.

Journal of the Fisheries Research Board of Canada.
28:786-788. May 1971.

Key Words: lead, nickel, arsenic, copper, antimony, cadmium, zinc, uranium, mercury, manganese, selenium, chromium, tin, fish.

Abstract:

The concentration of 13 toxic elements in dressed fish from a nonindustrialized and heavily industrialized freshwater area have been measured. With the exception of mercury, in no instance did levels exceed limits set by regulatory agents for lead, arsenic, copper, and zinc. Indeed in the majority of instances the levels from the industrialized area did not differ significantly from those of the nonindustrialized area.

Utilization of Sewage Wastes on Land.

Soil and Water Management Research Unit, U.S. Department of Agriculture. April 1974.

Key Words: phosphates, iron, manganese, zinc, copper, cadmium, lead, boron, crops.

Abstract:

This study was carried out to determine the effect of various types of sewage sludge on decomposition and availability of organic components as indicated by growth and composition of corn plants in a field experiment, and to determine the effect of various types of sewage sludge on measurable soil physical properties.

Vaccaro, R.F., M.P. Briggs, C.L. Carey, and B.H. Ketchum.

Viability of *Escherichia coli* in Sea Water.

American Journal of Public Health. 40(10):1257-1266. October 1950.

Key Words: *Escherichia coli*, coliforms, surface water (marine).

Abstract:

Escherichia coli populations are unable to survive when placed in raw sea water. This bactericidal action of sea water may contribute in an important way to the disappearance of coliform bacteria in tidal waters.

There is a marked seasonal variation in the length of time *E. coli* can survive in sea water. They are less viable in the summer months than in the winter.

Aging of raw sea water results in an increase in the bactericidal activity of the water. Aging of boiled and autoclaved waters produces little or no change in their bactericidal properties.

Sea water sterilized by boiling, autoclaving, pasteurizing, and chlorinating has less bactericidal activity than raw sea water.

The addition of organic matter decreases the bactericidal activity of sea water, but has less effect than various methods of sterilization.

It is concluded that the most probable cause of the death of *E. coli* populations in sea water is an antibiotic action which requires the presence of the normal marine flora.

Vacker, R., C. H. Connell, and W. N. Walls.

Phosphate Removal through Municipal Wastewater Treatment at San Antonio, Texas.

JWPCF. 39(5):750-771. May 1967.

Key Words: germanium, ammonia, BOD, nitrates, nitrites, activated sludge, trickling filters, effluent characteristics.

Abstract:

Up to 96 percent removal of total phosphate has been attained in an activated sludge plant where digester liquors are not returned to the system.

Activated sludge has "absorbed" as much as 20 to 22 percent phosphate, equivalent PO_4, dry weight basis.

For maximum phosphate removal a high degree of treatment is desired, but "overtreatment," i.e., excessive nitrification and aerobic digestion of solids; is detrimental.

When phosphate uptake by aeration solids is highly effective, there is no significant amount of leaching of phosphate from the solids passing through final clarifiers.

Maximum phosphate removal was obtained at an average daily BOD loading rate of about 50 lb BOD/100 lb aeration solids, at a sludge volume index of about 150, and when a DO level of about 2.0 mg/l was attained in the aeration tanks at about midpoint, and about 5 mg/l at the effluent end.

Vadas, R. L.

The Effects of PCB's and Selected Herbicides on the Biology and Growth of 'Platymonas subcordiformis' and Other Algae.

Universitv of Maine, Orono, Land and Water Resources Institute, June 1973. 38p. (Available from National Technical Information Service (NTIS) as PB-241 056).

Key Words: chlorinated hydrocarbons, herbicides, surface water (marine).

Abstract:

Growth rates and carrying capacities for Platymonas subcordiformis were determined using various concentrations of the PCB, Aroclor 1254, and the organophosphate, Malathion. Growth was slightly and completely inhibited by 100 and 1000 ppb respectively of Aroclor 1254. With Malathion growth inhibition was temporary or complete at 50 ppm or greater. At alkaline pH's the recovery of growth, especially at 50 ppm, took 3 to 5 days. At higher concentrations of Malathion recovery took longer if occurring at all. The inhibitory effects of Malathion, Aroclor, and chlorinated hydrocarbons are modified by inoculum densities, phase of algal growth at which the substance is added and in the case of the former possibly by the pH of the media.

Vaituzis, A., J.D. Nelson, Jr., L.W. Wan, and R.R. Colwell.

Effects of Mercuric Chloride on Growth and Morphology of Selected Strains of Mercury-Resistant Bacteria.

Applied Microbiology. 29(2):275-286. February 1975.

Key Words: mercury, bacteria, surface water (marine).

Abstract:

A survey of the comparative cytological effects of growth in the presence of mercury by a group of mercury-resistant bacterial cultures and a characterization of the process of bacterial adaptation to Hg^{2-} ion was accomplished. Mercury resistance was found to be dependent upon the ability to volatilize mercury from the medium and upon the amount of mercury accumulated by the cells. The results indicate that most cultures which adapt to growth in the presence of $HgCl_2$ exhibit extensive morphological abnormalities. Significant effects are delay in the onset of growth and cell division and numerous structural irregularities associated with cell wall and cytoplasmic membrane synthesis and function. A detailed analysis of the adaptation process and the resulting effects on morphology was performed on an Enterobacter sp. During the period preceding active multiplication, a selection for mercury-resistant mutants occurred. It was also demonstrated that growth commenced only at a specific threshold concentration of Hg^{2+}.

Vajdic, A. H.

Gamma Rays vs the *E. coli* Monster.

Water and Wastes Engineering. 12:29-32. July 1975.

Key Words: *Escherichia coli*, fecal streptococci, salmonella, radiation treatment.

Abstract:

This paper discusses a pilot plant experimentation on the removal of virus by gamma irradiation.

Vale, J. A. and G. W. Scott.

Organophosphorus Poisoning.

Guy's Hospital Reports. 123(13):13-25. 1974.

Key Words: organophosphorus pesticides, epidemiology.

Abstract:

Organophosphorus poisoning in Great Britain is discussed. The article includes a discussion of incidence, absorption, action, clinical features, cholinesterase activity, diagnosis, treatment, and prevention.

Vanadium: Medical and Biologic Effects of Environmental Pollutants.

Committee on Biologic Effects of Atmospheric Pollutants, National Academy of Sciences, Washington, D.C., 1974. 117p.

Key Words: vanadium, epidemiology.

Abstract:

This is an excellent reference book on vanadium, including discussions of industrial processes involving vanadium and its components, industrial uses of vanadium and its components, vanadium in the environment, and the biological effects of vanadium.

Van Bladel, R. and A. Moreale.

Adsorption of Fenuron and Monuron (Substantial Ureas) by Two Montmorillonite Clays.

Soil Science Proceedings. 38:244-249. March 1974.

Key Words: herbicides, groundwater, agricultural sludge disposal.

Abstract:

The effect of the type of clay mineral, exchangeable cation, temperature, and electrolyte concentration on the absorption of two substituted ureas was investigated.

The adsorption was greater on a Bentonite than on a Camp Berteau montmorillonite, possibly because the lattice charge in the former originates from tetrahedral and octahedral layers, whereas in the latter only from octahedral layers. The adsorption increased with the polarizing power of the exchangeable cation. Normal adsorption isotherms were exothermic but when the temperature effect on solubility was accounted for, the adsorption reaction tended to be more and more temperature independent as the electronegativity of the exchangeable cation increased. Relative thermodynamic data suggest that the favorable contribution to the adsorption energy arises mainly from enthalpy changes.

The effect of salt concentration was almost negligible up to 1.0N and for a given electrolyte good agreement was obtained between the heat of solution of the herbicide and its adsorption.

Vance, B. D. and W. Drummond.

Biological Concentration of Pesticides by Algae.

JAWWA. 61(7):360-362. July 1969.

Key Words: aldrin, dieldrin, endrin, DDT, surface water (fresh), surface water (marine).

Abstract:

The data show that algae, the basic members of the aquatic food chain, are extremely efficient potentiators of pesticide residues. It is assumed that, since concentration of many pesticides by certain algae occurs quite rapidly, and since there is apparently very little, if any, degradation of the pesticides by the algae, these highly concentrated residues can be biologically transferred to higher members of the food chain such as rotifers and small algal-feeding fish. The importance of this is that most higher members of the food chain do not appear to be nearly as resistant to these chlorinated compounds as do the algae, and, consequently, fish fills and similar catastrophies may be brought about in waters containing as little as 1 ppb of a pesticide. Such potentiation and biological transfer has been amply demonstrated, beginning with fish and continuing up the food chain to man. Algae, being the primary products in this chain, serve as an excellent tool for the study of pathways through which accumulated and magnified pesticide residues can find their way into the bodies of fish in streams containing little or no pesticide.

van der Leeden, F., L. A. Cerrillo, and D. W. Miller.

Ground-Water Pollution Problems in the Northwestern United States.

Geraghty and Miller, Inc., Port Washington, New York, May 1975. 378p. (Available from National Technical Information Service (NTIS) as PB-242 860).

Key Words: chromium, arsenic, phosphates, bacteria, chlorides, nitrates, groundwater, direct contact.

Abstract:

The most significant source of ground-water contamination is the discharge of sewage from septic tank systems. Three million people, equivalent to one-third of the area's total population, are served by individual septic systems. Mountain home sites in crystalline rock areas with thin soil cover and on-site water wells are particularly subject to pollution of drinking water supplies from septic effluent. High septic tank density in some urban and suburban sections has led to regional problems.

Discharge of treated or partially treated effluent from sewage treatment plants to rivers and streams is a potential hazard to ground-water quality, particularly in semi-arid regions. Shallow aquifers in the Plains states are especially vulnerable where unconsolidated valley aquifers are in hydraulic connection with a river, and pumpage from wells induces surface water to enter the aquifer.

Irrigation return flow is another pressing pollution problem. A total of 6.3 million ha (15.5 million acres), representing 4 percent of the project area, is under irrigation. As of 1960, about 840,000 ha (2 million acres) were affected by alinity. Nearly 50 percent of this area was in Colorado.

Van der Velden, W. and A. W. Schwartz.

Purines and Pyrimidines in Sediments from Lake Erie.

Science. 185:691-693. August 1974.

Key Words: synthetic/organics, surface water (fresh).

Abstract:

Quantitative analysis of purines and pyrimidines in sequential sections of cores from the central and eastern basins of Lake Erie show steeply increasing concentrations in the youngest sediments. This is related to the increased loading of nutrients and recent cultural eutrophication of the lake.

Vanselow, A.P.

Barium.

In: Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 24-32.

Key Words: barium, ponding/land application, land reclamation, groundwater, crops.

Abstract:

The author describes plant and soil criteria useful in diagnosing barium status, the toxicity of barium to plants, including tissue analysis values and the control of barium excess.

Vanselow, A.P.

Cobalt.

In: Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 142-156.

Key Words: cobalt, ponding/land application, land reclamation, groundwater, crops.

Abstract:

Cobalt received little attention from the agricultural standpoint until 1935. The author discusses plant and livestock criteria in diagnosing cobalt status mentioning symptoms of cobalt deficiency, indicator plants and tissue analysis values. He also lists kinds of soils in which cobalt deficiency most commonly occurs and gives soil management and other practices which aggravate or reduce cobalt deficiency and soil analysis values of significance, including cobalt deficiency and its control.

Vanselow, A.P.

Nickel.

In: Diagnostic Criteria for Plants and Soils. H. D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 302-309.

Key Words: nickel, ponding/land application,
land reclamation, groundwater, crops.

Abstract:

Among the many chemical elements found in most plants, but of unproven essentiality, is nickel. The author discusses visual symptoms of and indicator plants for nickel excess, tissue analysis values, soil criteria useful in diagnosing nickel status and briefly, the control of nickel toxicity.

Varanka, M.W., Z.M. Zablocki, and T.D. Hinesly.

The Effect of Digested Sludge on Soil Biological Activity.

JWPCF. 48(7):1728-1740. July 1976.

Key Words: zinc, nickel, chromium, lead, cadmium, copper, total organic carbon, phosphates, nitrates, agricultural sludge disposal, crops.

Abstract:
Studies were conducted by using soil samples collected at three different times during the 1974 growing season from the control and sludge-amended Blount silt loam soil. Anaerobically digested sludge was applied each year for a period of 6 yr, resulting in accumulative loading rates of 0, 92, 184, and 369 metric tons/ha and an increase in soil concentrations of Cu, Cd, Cr, Ni, Pb, Zn, and P. While concentration levels of all the heavy metals in the maximum sludge-treated plots were above typical soil levels, only Cd and Zn concentration levels exceeded those that might be expected in the upper range of values reported for normal soils.

Almost three and one-half-fold increases in P and two-fold increases in C and N contents were found in soil samples from maximum sludge-treated plots as compared with concentrations in samples from control plots.

No clear-cut evidence of restrictions in microbial populations and their activities was observed. Although total bacteria, fungi, and actinomycetes populations were never less in maximum sludge-treated plots, a significant increase in the populations for each of the major groups as a result of sludge applications was recorded only once during three sampling dates. Percentage of denitrifiers, protease, and amylase activities were increased as a result of sludge applications, while invertase and urease activities were unaffected by sludge treatments. An increase in dehydrogenase activity was exhibited only in soil samples collected from sludge-amended plots during the last sampling period. The increase in dehydrogenase activity was probably in response to sludge applied by furrow irrigation during the growing season. Only the percentage of Azotobacter and cellulase activity were each decreased by sludge treatments at one sampling period. These two latter measurements of microbiological changes in sludge-amended soils were included in a much expanded program of studies to be conducted during the 1975 growing season.

Varma, M. W., B. A. Christian, and D. W. McKinstry.

Inactivation of Sabin Oral Poliomyelitis Type I Virus.

JWPCF. 46(5):987-992. May 1974.

Key Words: polio virus, chlorination.

Abstract:

The minimum concentration of chlorine required for complete inactivation of the Sabin oral poliovaccine Type I virus (L-Sc) strain, with various exposure periods at pH 5.2 at 20°C was found to be 22 mg/l for 5 min, 19 mg/l for 15 min, 19 mg/l for 30 min, 17 mg/l for 45 min, and 14 mg/l for 60 min.

Vaughn, J. M. and J. H. Ryther.

Bacteriophage Survival Patterns in a Tertiary Sewage Treatment-Aquaculture Model System.

Aquaculture. 4:399-406. 1974.

Key Words: viruses, aquaculture.

Abstract:

A system has been developed at the Woods Hole Oceanographic Institution that combines tertiary treatment of sewage with marine aquaculture. In this system, unchlorinated secondary sewage effluent is initially diluted with sea water and used as a culture medium for the growth of unicellular marine algae. The algae utilize and thereby remove the sewage nutrients, and are in turn used as a food source for bivalve mollusks (i.e., oysters, clams, mussels and scallops). Solid wastes regenerated by the shellfish, in the form of feces and pseudofeces, are then fed to a secondary crop of detrital-feeding fishes (e.g., mullet) crustacea (e.g., lobsters, crabs and shrimp) or other invertebrates (e.g., polychaete worms such as *Capitella capetata* or *Nereis virens*). Dissolved wastes produced by the shellfish are utilized by crops of macroscopic algae such as *Chondrus crispus*. The net products from the system are an effluent containing lower concentrations of nutrients than natural sea water and valuable crops of marine animals and plants.

Initial laboratory scale experiments have been expanded to the construction of a pilot plant facility, the Environmental Systems Laboratory (ESL) in Woods Hole, Mass., having a maximum capability of processing 100,000 gallons of sewage effluent per day (1 US gal = 3.785 l).

Of utmost concern is the presence of pathogenic human viruses in the sewage effluent and their potential threat to the social and legal acceptability of the products of the aquaculture system. Previous studies have shown that viruses are readily accumulated by filter-feeding mollusks, and that ingestion of these contaminated shellfish by humans may result in disease. The ability of viruses to withstand the rigors of a sewage-sea water environment and rapidly growing algal cultures, and their resultant contamination of shellfish species would present a serious impediment to any commercial development of a sewage-aquaculture system. To investigate these problems on a preliminary basis the authors examined certain bacteriophage survival parameters in laboratory-scale algal cultures grown on sewage effluent.

Vaughn, J. M. and T. G. Metcalf.

Coliphages as Indicators of Enteric Viruses in Shellfish and Shellfish Raising, Estuarine Waters.

Water Research. 9:613-616. 1975.

Key Words: viruses, *Escherichia coli*, shellfish, surface water (fresh), surface water (marine).

Abstract:

The practicality of a coliphage indicator system for human enterovirus in polluted waters was studied. Parallel examinations of sewage effluents, shellfish and shellfish growing waters for coliphage and enteric virus indicated a wide dissemination of coliphage throughout the estuary, generally occurring in the absence of detectable enteric virus activity. A majority of the enteric virus isolations were observed in samples yielding no coliphage activity. Under controlled conditions, oysters were observed to accumulate more coliphage than enteric virus. Replication of coliphage in the estuary during the summer months was shown to occur when proper host cell was present. Two major coliphage types were observed in field samples based on that reactivity with different *Escherichia coli* strains. A shift in dominant coliphage type was seen to occur during the study. Survival times of coliphage and enteric virus in estuary waters along with retention values in oysters were shown to be similar with a slight advantage shown by coliphage.

Inability to correlate accurately coliphage and enteric virus occurrence in field samples along with the potential for the presence of more than one dominant coliphage type indicated the serious shortcomings of the coliphage indicator system as a method of enteric virus detection, leaving its overall use in the polluted environment subject to grave doubt.

Vela, G. R. and E. R. Eubanks.

Soil Microorganism Metabolism in Spray Irrigations.

JWPCF. 45(8):1789-1794. August 1973.

Key Words: bacteria, ponding/land application.

Abstract:

This is the report of a systematic study of the microbial activities in a spray irrigation wastewater treatment plant. The following points were proven by the research reported herein.

1. Although the process water contained great amounts of raw animal and vegetable tissues, there was no enzymatic activity in the water.

2. Although there were large numbers of viable bacteria in the plant effluent, these contributed little or nothing to the purification process.

3. Specific bacterial populations had developed in the spray fields as a result of application of the cannery wastewater and it was these bacteria that brought about hydrolysis of polymers and oxidation of monomers in the water.

4. Only a small fraction (16 of 100 species) of the bacterial population contributed directly to the purification process; the majority of the population probably contributed indirectly.

5. There was no correlation between total numbers of bacteria and oxidative capacity of the soils in the spray field.

Venosa, A.D.

Ozone as a Water and Wastewater Disinfectant: Literature Review.

In: Ozone in Water and Wastewater Treatment. F.L. Evans, ed.
Ann Arbor Science Publishers, Ann Arbor, Michigan, 1972. pp. 83-100.

Key Words: *Escherichia coli*, *Clostridium welchi*, parasitic worms, *Clostridium botulinium*, ozonation.

Abstract:

It is evident that there exists much controversy, contradiction, confusion, and nonfactual subjective judgment concerning the use of ozone for disinfection of water and wastewater. For example, it is often quite difficult to discern whether the authors are discussing ozone residual or applied ozone when reporting data on concentrations necessary for a certain microbicidal effect. In many instances, the method of ozone analysis is subject to critical examination. The possibility of aftergrowth of microorganisms in a receiving water was mentioned as an inherent problem with chlorination practices. Since aftergrowth phenomena are presumed by many to be caused by incomplete disinfection due to protective effects (such as clumps or other factors rather than propagation of chlorine-resistant organisms), then it follows that this problem would still be present with ozonation provided the same protective factors are working.

Clearly, ozone is an extremely powerful oxidizing agent, at least as effective in all aspects as chlorine. However, there is a great need for objective, controlled, and reproducible data on ozone disinfection technology. Numerous questions need to be answered. What is the most reliable and precise method of ozone analysis? Does ozone really impart an all-or-none germicidal effect, or is the effect a typical exponential disinfection pattern similar to chlorine? What is the effect of ozone on industrial wastes? What effects do the ozonated effluents have on fish and aquatic life? Some comparative work has been done on this question by Arthur and his associates at Duluth. However, more studies with a variety of different effluents are needed. Finally, what is the objective estimate of the costs of both installation and operation of ozonating equipment? These questions are vital to a true understanding of ozonation, and only through thorough evaluation and experimentation, both on a bench-scale and pilot-plant basis, will they be answered adequately.

Venosa, A. D. and C. W. Chambers.

Bactericidal Effect of Various Combinations of Gamma Radiation and Chloramineon Aqueous Suspensions of Escherichia coli.

Applied Microbiology. 25:735-744. May 1973.

Key Words: Escherichia coli, chlorination, radiation treatment.

Abstract:

Methods of combining gamma radiation with chloramine to disinfect aqueous suspensions of Escherichia coli were investigated. Logarithmically grown cells were exposed to the bactericidal agents sequentially (i.e., radiation followed by chloramine, and chloramine followed by radiation) and simultaneously. Regardless of which combination was used, the bactericidal effect was always less than additive. During the phase of work involving the simultaneous addition of both agents, it was observed that chloramine was destroyed more rapidly by radiation than were the organisms. Since an increase in the bactericidal effectiveness of either disinfectant by prior or simultaneous treatment of the cells with the other disinfectant was not achieved in buffered distilled water, it was concluded that disinfection of wastewater effluents by combining ionizing radiation with chloramine would not be economically feasible.

Versteeg, J. P. J. and K. W. Jager.

Long-term Occupational Exposure to the Insecticides Aldrin, Dieldrin, Endrin, and Telodrin.

British Journal of Industrial Medicine. 30(2):201-202. 1973.

Key Words: aldrin, dieldrin, endrin, epidemiology.

Abstract:

A medical survey of 233 long-term insecticide workers has previously been published. Fifty-two of them had left employment at the time of the original publication. All members of this group could be traced. No unexpected adverse effects on health were found. Their disease pattern and general well-being were not different from those in the original group.

Viets, F.G., Jr. and R.H. Hageman.

Factors Affecting the Accumulation of Nitrate in Soil, Water, and Plants.

Agricultural Handbook No. 413. U.S. Department of Agriculture, Washington, D.C., November 1971. 63p.

Key Words: nitrates, surface water (fresh), groundwater, crops, ponding/land application.

Abstract:

The authors' evaluation of available information on nitrate in soil, water, foods and feeds is that the potential for nitrate accumulation does not pose a threat of an environmental crisis. There is no widespread upward trends of nitrate concentrations in foods, feeds, surface or ground water.

Villa, O., Jr. and P. G. Johnson.

Distribution of Metals in Baltimore Harbor Sediments.

Environmental Protection Agency, Annapolis, Maryland, Annapolis Field Office, January, 1974. 71p. (Available from National Technical Information Service (NTIS) as PB-229 258).

Key Words: cadmium, chromium, copper, lead, manganese, mercury, zinc, surface water (fresh), surface water (marine).

Abstract:

In order to develop a current inventory of metals contamination of Baltimore Harbor, sediment samples were collected at 176 stations and analyzed for Pb, Cu, Cr, Cd, Zn, Ni, Mn and Hg using atomic absorption spectrophotometry. Concentration levels were compared with levels found in another highly industrialized harbor complex, other estuarine systems and in Chesapeake Bay sediments geographically removed from the Harbor. Distribution patterns of various metals were related to industrial/municipal inputs.

Viruses in Water.

JAWWA. 61(10):491-494. October 1969.

Key Words: viruses, surface water (fresh), chlorination.

Abstract:

There is no doubt that water can be treated so that it is always free from infectious microorganisms--it will be biologically safe. Adequate treatment means clarification (coagulation, sedimentation, and filtration), followed by effective disinfection. Effective disinfection can be carried out only on water free from suspended material. The importance of this latter point has been vividly pointed out by researchers who describe a situation in which coliforms were consistently isolated from waters containing from 0.1-0.5 mg/l free chlorine and between 0.7-1.0 mg/l total chlorine after 30-min contact time. This water had turbidity values of from 3.8 to 84 units, contained iron rust, and occasionally had biological organisms of 2,000 units. Viruses, because of their small size, would probably more easily become enmeshed in a protective coating of turbidity-contributing matter than bacteria would. For most effective disinfection, turbidities should be kept below 1 Jackson Unit; indeed, it would be best to keep the turbidity as low as 0.1 unit, as recommended by AWWA water quality goals. The limit of 5 Jackson Units of turbidity specified in the USPHS _Drinking Water Standards, 1962_. is meant to apply to protected watersheds and not to filtration plant effluents. With turbidities as low as 0.1 to 1, a preplant chlorine feed need be only enough to have a 1 mg/l free chlorine residual after 30-min contact time. Postchlorination practice would depend upon the ability to maintain such residuals throughout the distribution system.

In conclusion, there does not appear to be cause for panic or overreaction to the problem of viruses in water. Under certain conditions, infectious hepatitis can be transmitted by treated water, but the evidence indicates that in such cases treatment was inadequate. The evidence for the transmission of other enteric viruses by treated water is, for the most part, speculative, with the possible exception of viral gastroenteritis and diarrhea, and nothing much is known about these viruses. These statements, however, do not mean we can be smug or complacent. There is still considerable room for research, both laboratory and epidemiologic, to determine if there is a problem

in virus disease transmission by water; to determine if the coliform index is always adequate (positive coliform tests certainly indicate possible virus contamination, but a negative coliform test may not indicate freedom from viruses); to devise better techniques for measuring viruses in water; to develop a laboratory method of detecting viruses of infectious hepatitis; and to develop a sound method of detecting small numbers of viruses in large volumes of water.

Voelkel, K.G., D.W. Martin, and R.W. Deering.

Joint Treatment of Municipal and Pulp Mill Effluents.

JWPCF. 46(4):634-656. April 1974.

Key Words: suspended solids, BOD, gravity separators, air flotation, centrifugal thickeners, heat treatment, vacuum filters, pressure filtration, activated sludge.

Abstract:

A combination of weak pulping effluents from the calcium-base sulfite, ammonia-base sulfite, de-inking, and neutral semichemical pulping processes can be treated successfully jointly with municipal wastewater in an activated sludge treatment plant.

Activated sludge systems that incorporate reaeration of the return activated sludge are more stable in treating this particular combination of wastes. Of the four activated sludge processes studied (conventional, step aeration, contact stabilization, and Kraus), the contact stabilization process proved to be the most successful in treating this particular combination of wastes.

Filamentous sulfide bacteria growth in the mixed liquor was controlled successfully by the continuous addition of 5 to 10 mg/l of chlorine to the return activated sludge. Low dissolved oxygen concentrations were not successful in controlling the filamentous sulfide bacteria. The addition of chlorine to the return activated sludge did not control nonfilamentous bulking.

Nitrogen and phosphorous additions were required to achieve satisfactory biological operation. There was no advantage to adding the nutrients in the reaeration section as opposed to the contact section of the activated sludge process.

Satisfactory operation was achieved at dissolved oxygen levels between 0.5 and 1.5 mg/l.

It is more economically advantageous to bypass these mill effluents directly to the secondary treatment unit than to provide primary clarification for these effluents.

During a consecutive period of 4.5 months of contact stabilization pilot plant operation, the BOD, TSS, and color removal averaged 91, 78, and 10 percent, respectively. Increased TSS removals are expected in a full-scale final clarifier.

Vogt, J.E.

Impact of Wastewater Discharges on Surface Water Sources.

JAWWA. 64(2):113-117. February 1972.

Key Words: ammonia, chlorides, cyanides, chromium, phosphates, coliforms, groundwater, surface water (fresh).

Abstract:

Water-pollution-control agencies and their activities are essential to the protection of sources of community water supplies.

Wastewater treatment plants are an important line of defense in the protection of the public's health as they relate to the water people drink and use for domestic purposes and water that is supplied to industry through water utilities.

There must be a direct line of communication between the wastewater utility and the water utility it may affect. This has proved to be very important on many occasions.

One must continue to sharpen the tools available in both water- and wastewater-treatment plants to do a more effective job.

The operators of both utilities play an extremely vital role carrying out the mandate to protect the public health.

Von Rümker, R., E.W. Lawless, and A. F. Meiners.

Production, Distribution, Use and Environmental Impact Potential of Selected Pesticides.

Midwest Research Institute, Kansas City, Missouri, March 1974. 453p. (Available from National Technical Information Service (NTIS) as PB-238 795).

Key Words: aldrin, chlorinated hydrocarbons, herbicides, air, direct contact, surface water (fresh), surface water (marine).

Abstract:

The production, distribution, use patterns, and potential for environmental impacts of pesticides are described, with emphasis on 25 important pesticides that were selected by applying a priority rating system to 125 major pesticides. Information on environmental impact potential, wasteful use practices, and alternative methods of pest control are discussed in general and in particular for each of the intensive-study pesticides.

Vreeland, V.

Uptake of Chlorobiphenyls by Oysters.

Environmental Pollution. 6(2):135-140. February 1974.

Key Words: chlorinated hydrocarbons, shellfish.

Abstract:

Accumulation of individual chlorinated biphenyls in small oysters was proportional to the degree to chlorination of the isomer and to its concentration in seawater at environmental levels. Equilibrium was reached after one month, with concentration factors of 1200 to 48,000 for isomers with 2 to 6 chlorine atoms/molecule. Partitioning of PCB between more hydrophobic lipids and ambient seawater has been rejected as the uptake mechanism.

Wachinski, A.M., V.D. Adams, and J.H. Reynolds.

Biological Treatment of the Phenoxy Herbicides 2,4-D and 2,4,5-T in a Closed System.

Utah Water Research Laboratory, Utah State University, Logan, March 1974. 25p.

Key Words: synthetic/organics, activated sludge.

Abstract:

The Air Force is evaluating the problem of ecologically safe disposal of approximately 2.3 million gallons of surplus stock of herbicide Orange. This report provides data and information on the feasibility of using a closed aerobic/anaerobic system for the controlled biological (microbial) degradation of the herbicide. Research data have shown that even massive concentrations (under less than optimum conditions) of 2,4-D and 2,4,5-T can be degraded by microorganisms in an acceptable time frame. Moreover, indications are that the process can be accomplished in such a manner as to preclude the introduction of toxic materials into the biosphere. Specific details are provided on the configuration, approximate cost, capacity, and size of a proposed closed treatment facility.

Walker, J.M.

Trench Incorporation of Sewage Sludge.

In: Municipal Sludge Management; Proceedings of the National Conference on Municipal Sludge Management, June 11-13, 1974. pp. 139-149.

Key Words: nitrates, salmonella, coliforms, chlorides, groundwater.

Abstract:

Entrenchment seems a feasible method for simultaneously disposing of sewage sludges and improving marginal agricultural land, particularly for dewatered (20 percent solids) raw-limed sludge. The primary problem will be to avoid pollution of groundwater with nitrate-nitrogen, as demonstrated in test with sewage sludge (5 and 20 percent solids) placed in 60-cm (two-foot) wide trenches of different depths and spacings. For dewatered sludge, application rates were 800 and 1200 Mt/ha (350 and 500 tons/acre) dry solids, respectively, in trenches 60-cm wide x 60-cm deep x 60-cm apart and 60-cm wide x 120-cm deep x 120-cm apart.

Entrenchment prevented contamination of surface water, buried pathogens permitting their demise during sludge decomposition, promoted slow nitrogen release, and favored denitrification.

Walker, J.M. and G.B. Willson.

Composting Sewage Sludge.

Compost Science. 14(4):10-12. July-August 1973.

Key Words: coliforms, salmonella, composting.

Abstract:

Data indicates that composting will not be an acceptable method of disposal of sewage sludge from the standpoint of biological pathogens. During the composting process it was found that salmonellae and fecal coliform experience a gain.

Wallace, R.N. and D.E. Burns.

Factors Affecting Powdered Carbon Treatment of a Municipal Wastewater.

JWPCF. 48(3):511-519. March 1976.

Key Words: suspended solids, adsorption/ion exchange.

Abstract:

This is original research describing soluble organic removal by a powdered carbon system, 50% by physical adsorption, 50% by anaerobic biological activity.

Waller, D.H.

Pollution from Combined Sewer Overflows.

In: Proceedings of the Conference on Pollution, St. Mary's University, Halifax, August 1969. pp. 67-80.

Key Words: fecal streptococci, coliforms, combined municipal and/or storm systems.

Abstract:

This article is a fairly popular review of the nature and extent of problems associated with combined sewers and the work undertaken by the Atlantic Industrial Research Institute that is intended to provide answers to some of the questions that appear when attempts are made to solve the problems.

Wallihan, E.F.

Iron.

In: Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 203-212.

Key Words: iron, ponding/land application, land reclamation, groundwater, crops.

Abstract:

The one widespread, and perhaps universal, symptom of iron deficiency in green plants is a reduced concentration of chlorophyll, a condition commonly known as "chlorosis". The author describes confirmatory tests and indicator plants for iron deficiency, tissue analysis values, soil criteria useful in diagnosing iron status control and methods of correcting iron deficiency.

Wallihan, E.F.

Tin.

In: Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 476-477.

Key Words: tin, crops.

Abstract:

Tin occurs in all soils, primarily as resistant minerals and is generally a biologically innocuous element. There appears to be no substantial evidence that tin is essential or beneficial to plants in any way, and it has not been shown to be detrimental under field conditions.

Walter, C.M., F.C. June, and H.G. Brown.

Mercury in Fish, Sediments, and Water in Lake Oahe, South Dakota.

JWPCF. 45(10):2203-2210. October 1973.

Key Words: mercury, surface water (fresh), fish.

Abstract:

The primary finding of this study was that fish with total mercury concentrations in excess of 0.5 mg/kg occurred with higher frequency in samples collected from the Cheyenne River arm than in samples from any other location in Lake Oahe or its tailwaters. Highest concentrations were found in northern pike and walleye, although eight other species of game or commercially caught food fishes showed concentrations equal to or above 0.5 mg/kg. Thus, there is public concern as well as scientific interest in the mercury content of fish in this reservoir.

Because tailings and effluents containing mercury from the Homestake Mining Company mill at Lead-Deadwood have been deposited in Whitewood Creek and have been positively identified in water, sediments, and fish samples collected downstream from the discharge site, it seems that mercury from the company sources enters the water and sediments and is carried by tributaries into the Cheyenne River arm. This conclusion is supported by the fact that higher concentrations of mercury were found in mid-channel sediment samples from the Cheyenne River arm and by the decrease of concentrations in samples in a downstream direction. Both the latter findings might be expected because the sediment load from the Cheyenne River moves through the old river channel of the upper Cheyenne arm, and, except during periods of heavy runoff, much of the sediment load settles out in the upper reach. The mercury content of the dredge samples, therefore, may not represent the total amount of mercury present in the Lake Oahe sediments, but it suggests a possible source of the mercury found in fish.

Although Homestake Mining Company discontinued the use of mercury in its gold recovery process in December 1970, sampling in 1971 by EPA demonstrated that effluents discharged into Whitewood Creek still contained an estimated 1.1 kg of mercury/day. Thus, a monitoring program to assess the incidence and

concentration of mercury in fish in the future seems desirable. Fish sampling for this type of program might be limited to several indicator species including northern pike and walleye. In view of the circumstances surrounding the incidence and distribution of mercury in the Cheyenne River system and the absence of other known industrial or agricultural sources of mercury in the area, there is a unique opportunity to make a thorough investigation of the cycling of mercury in a freshwater ecosystem and the fate and effects of mercury in that ecosystem after the source has been reduced or removed.

Walter, M.F.

Nitrate Movement in Soil Under Early Spring Conditions.

University of Wisconsin, Madison, Water Resources Center, 1974. 161p. (Available from National Technical Information Service (NTIS) as PB-240 094).

Key Words: ammonia, nitrates, nitrites, time of year, land reclamation, ponding/land application.

Abstract:

Physical transport mechanisms and chemical transformations of nitrogen were investigated and a quantitative mathematical model was developed of manure nitrogen movement through soil profiles under typical early spring conditions. Nitrogen transformation studies were conducted with batch systems of Plainfield sand and anaerobic dairy waste. Laboratory soil columns were used to investigate flow and transport processes. The specific conditions studied were temperatures from 0° to 20°C soil moisture from 5 to 20% by dry soil weight, soil pH from 6 to 8, and aerobic soil environment. The quantity of nitrate in an incremental volume of soil depended upon its movement in or out of the soil volume due to mass flow of water and to the net production of nitrate within the volume of soil due to mineralization of organic nitrogen and nitrification of ammonium. Nitrate accumulation as predicted by the computer model was based on nitrification of added manurial ammonium and soil nitrogen mineralization. Estimates of solute dispersion were made based on the movement of the soil water after infiltration.

Wang, W.C.

Adsorption of Phosphate by River Particulate Matter.

Water Resources Bulletin. 10:662-671. August 1974.

Key Words: phosphates, surface water (fresh).

Abstract:

The adsorption of phosphate on particulate matter from the Illinois and Spoon Rivers was investigated. Adsorption reached equilibrium after 5 to 6 days and adsorption isotherms were linear for both constant and varying amounts of particular matter. Adsorption was a maximum at pH 8.3 and a minimum at 6.0.

Wang, W.L.L., S.G. Dunlop, and P.S. Muncon.

Factors Influencing the Survival of Shigella in Wastewater and Irrigation Water.

JWPCF. 38(11):1775-1781. November 1966.

Key Words: shigella, surface water (fresh), groundwater.

Abstract:

In fresh wastewater, the survival of *Shigella flexneri* II is independent of the number of natural phage particles present, but is significantly better when the total plate counts are low and the natural temperature low.

In irrigation water, the survival of shigella is also independent of natural phage, but is better with lower total counts and lower temperatures.

A controlled study with wastewater using 2 temperatures, 15° and 25°C, showed significantly better recovery of shigella at the lower temperature.

There is no simultaneous increase in bacteriophage to correspond with the poor recovery of shigella added to wastewater or irrigation water.

Ward, P.S.

Carcinogens Complicate Chlorine Question.

JWPCF. 46(12):2638-2640. December 1974.

Key Words: synthetic/organics, chlorination.

Abstract:

This paper discusses general safety concerns of producing carcinogenic chemicals through chlorination.

Warner, T.B.

Mixing Model Prediction of Fluoride Distribution in Chesapeake Bay.

Journal of Geophysical Research. 77:2728-2737. May 1972.

Key Words: fluorides, surface water (fresh), surface water (marine).

Abstract:

If estuarine waters are simple mixtures of river water and sea water, then amounts of trace constituents expected at a given location (if there is not a source or sink within the system) can be predicted from measured chlorinities and knowledge of the composition of fresh- and sea-water inputs. This simple model was tested by comparing measured and predicted fluoride concentrations in Chesapeake Bay surface water and was found to predict the distribution within 2 to 3% depending on the variability of input fresh-water sources. Thus there are no important sinks for fluoride within the system. This approach allows identification of non-conservative species and can be useful for the quick identification of the probable direction toward and magnitude of sources of conservative polluting substances. Variations in input waters can be reliably inferred from measurements in the body of the estuary far from the source.

Wastewater Filtration: Design Considerations.

EPA Technology Transfer, U.S. Environmental Protection Agency, Washington, D.C., July 1974. 36p.

Key Words: suspended solids, filtration.

Abstract:

The key questions involved in the proper design of granular filters for the filtration of secondary effluents have been discussed, and design recommendations have been presented. These recommendations are summarized as follows:

The variable hydraulic and suspended solids in secondary effluents must be considered in the design to avoid short filter runs and excessive backwash-water requirements.

A filter that allows penetration of suspended solids (e.g., a coarse-to-fine filtration system) is essential to obtain reasonable filter run lengths. The filter media on the influent side should be at least 1 to 1.2 mm.

The backwash-water flow rate should be large enough to fluidize the coarser-sized grains of each component of the filter media. More uniform media sizes will reduce the backwash flow rate required and are thus desired, even though the cost of the media will be increased.

Auxiliary agitation of the media is essential to proper backwashing. Either air scour or surface (and possibly subsurface) washers should be installed.

The effect of recycling of used backwash water through the plant on the filtration rate and filter operation must be considered in predicting peak loads on the filters and resulting run lengths.

The filtration rate and terminal headloss should be selected to achieve a minimum filter run length of 6 to 8 hours during peak-load conditions. This requirement will mean an average run length of about 24 hours if flow equalization is not provided. Estimates of headloss development and filtrate quality preferably should be based on pilot-scale observations at the particular installation. If such studies are not feasible, headloss development should be based on past experience on the suspended solids capture per foot of headloss increase from other similar installations.

High filtration rates (3 gal/min/ft^2 or higher at average load) and/or high influent suspended solids to the filters (30 mg/l or higher at average load) will cause high terminal headlosses and may favor the use of pressure filters over gravity filters, especially for smaller plants with limited capital resources.

Lower filtration rates or lower influent suspended solids may permit the economical use of gravity filters, especially in larger plants where multiple filters will be needed. At least two, and preferably four, filters should be provided. If only two filters are provided, each should be capable of handling peak design flows to allow for one filter to be out of service for backwashing or repair. If four or more gravity filters are provided, the variable declining-rate method of operation is strongly recommended.

This publication does not attempt to present detailed discussion of all elements of filter design that have been well established in water-treatment practice and are presented in various text books. Rather, the emphasis is on the differences between water-treatment practice and wastewater-treatment practice, which must be considered for successful design of wastewater filters.

Water Quality Criteria Data Book. Vol. II: Inorganic Chemical Pollution of Freshwater.

Water Pollution Control Research Series. U.S. Environmental Protection Agency, July 1971. 280p. (Available from National Technical Information Service (NTIS) as PB-208 988).

Key Words: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, germanium, lead, manganese, mercury, molybdenum, nickel, selenium, thorium, tin, uranium, zinc, ammonia, nitrates, surface water (fresh).

Abstract:

This is an excellent reference giving levels of contaminants in all U.S. surface waters. In addition there is a great deal of information on toxicologal effects.

Water Quality Criteria Data Book. Vol. III: Effects of Chemicals on Aquatic Life.

Water Pollution Control Research Series. U.S. Environmental Protection Agency, May 1971. 528p. (Available from National Technical Information Service (NTIS) as PB-213 210).

Key Words: fish, shellfish.

Abstract:

This volume is not directly applicable to public health considerations; however, it is a compendium of the effects of various chemicals on aquatic life.

Water Quality Criteria Data Book. Vol. IV: An Investigation into Recreational Water Quality.

Water Pollution Control Research Series. U.S. Environmental Protection Agency, April 1972. 256p. (Available from National Technical Information Service (NTIS) as PB-214 154).

Key Words: polio virus, coxsackie virus, ECHO virus, adeno virus, coliforms, fecal streptococci, drinking and recreational water, salmonella.

Abstract:

The Envirogenics Co., under sponsorship of the EPA, has developed a new technique for establishing firm criteria for health risks associated with recreational water bodies. Initial analysis of data required in this methodology has demonstrated that scientifically valid standards for recreational water quality can be formulated that should replace the present rather arbitrary standards.

The basis of the method is a mathematical treatment of medical dose-response data in conjunction with the probability of exposure over a period of time to a given level of the potentially harmful "factor" such that a quantitative risk can be assigned to the recreational activity. Once a public health jurisdiction has established an acceptable level of risk (perhaps in association with Federal quality guidelines), curves produced by electronic data processing equipment can be used to ascertain whether a particular water should be open to the public.

While sufficient data have been found on both the health effects and the distribution of key factors to verify the effectiveness of the recommended procedure, informational gaps prevent the immediate adoption of the system. The gathering of information to establish realistic standards for key health-oriented factors would be an undertaking that could be accomplished in a relatively modest program. Once the essential information is obtained, it will be possible to put into practice the new Envirogenics-developed criteria procedure with the most critical factors. This advancement would be of great significance to the entire field of water quality standards.

Water Quality Criteria Data Book. Vol V: Effects of Chemicals on Aquatic Life.

Water Pollution Control Research Series., U.S. Environmental Protection Agency, September 1973. 537p. (Available from National Technical Information Service (NTIS) as PB-234 435).

Key Words: other (general) elemental, other (general) pesticides, fish, shellfish.

Abstract:

This article is not directly applicable to public health considerations, however, the article is a compendium of the effects of various chemicals on aquatic life.

Water Scare May Boost Pollution Cleanup.

Chemical Engineering. 82(6):31-32. March 17, 1975.

Key Words: synthetic/organics, chlorinated hydrocarbons, drinking and recreational water.

Abstract:

EPA's search for the sources of drinking-water contaminants could force reduction of some pollutants sooner and more extensively than planned.

Watkins, S.H.

Coliform Bacteria Growth and Control in Aerated Stabilization Basins.

Crown Zellerbach Corporation, Camas, Washington, Environmental Sciences Division, December 1973. 301p. (Available from National Technical Information Service (NTIS) as PB-231 259).

Key Words: coliforms, bacteria, BOD, chlorination, surface water (fresh), fish, effluent characteristics.

Abstract:

The State of Oregon has a standard of 1000 coliform bacteria (coliforms) per 100 ml for recreational waters. Secondary effluent from a sulfite mill in Lebanon, Oregon consistently had the potential to increase the coliform population in the South Santiam River to concentrations greater than 1000 per 100 ml. This provided an opportunity to determine factors responsible for high coliform levels in an industrial waste and to develop methods for reducing their numbers. The high concentrations of coliforms in Lebanon effluent were not due to their growth during secondary treatment but rather reflected development at earlier stages. In a small scale system, coliforms were reduced to acceptable levels in a secondary treatment unit by killing them in the incoming wastes. Methods for accomplishing this on a full scale were not found, therefore disinfection was investigated as an alternative. A modified chlorination system which employed caustic injection into the chlorinator's water supply was the most effective treatment tested. The ability of the process to reduce coliforms to acceptable levels in the South Santiam River was demonstrated. Chemical analyses and fish bioassays showed that the process would not contribute toxic chlorine residuals to the receiving waters. Rapid methods for estimating colicidal activity are described. Factors which affect coliform populations in mill systems and those which affect chlorine activity are discussed.

Watling, L., W. Leathem, P. Kinner, C. Wethe, and D. Maurer.

Evaluation of Sludge Dumping off Delaware Bay.

Marine Pollution Bulletin. 5(3):39-42. March 1974.

Key Words: aluminum, iron, zinc, manganese, lead, cadmium, chromium, copper, tin, cobalt, barium, beryllium, boron, molybdenum, surface water (marine).

Abstract:

Sewage sludge from Philadelphia and Camden has been dumped off the mouth of Delaware Bay since 1961. Local residents have claimed that sludge is washed ashore, is a health hazard and has impoverished the fauna of the seabed in the area. In the survey reported here, an assessment has been made of the composition and abundance of the benthic marine fauna of the dumping grounds.

Wauchope, R.D. and R. Haque.

Effects of pH, Light and Temperature on Carbaryl in Aqueous Media.

Bulletin of Environmental Contamination and Toxicology.
9(5):257-260. May 1973.

Key Words: synthetic/organics, surface water (fresh).

Abstract:

Carbaryl (N-methyl-1-naphthylcarbamate) has been shown to degrade after estuarine application to products which are toxic to some marine species, and solution pH, light and temperature have been shown to be significant factors in determining the rate and pathway of degradation. Light irradiation of carbaryl solutions of various pH has shown that it is the naphthoxide ion produced by carbaryl hydrolysis in basic solution which is particularly sensitive to photo-oxidation.

Weaver, P.J.

Phosphates in Surface Waters and Detergents.

JWPCF. 41(9):1647-1653. September 1969.

Key Words: phosphates, surface water (fresh).

Abstract:

This is a brief description of the sources and control of phosphates in water as well as their role in detergents. While necessarily sketchy, it is hoped that the complexities of the different aspects have been emphasized. There has been no intention of taking an argumentative position defending phosphates; if phosphates are truly the key to controlling eutrophication, then the detergent industry is as interested as anyone else in finding ways to prevent them from getting into surface waters. The industry's efforts in trying to find answers exemplify its interest. Supported studies on removal of phosphorus, sources of phosphorus, the basic causes of eutrophication, etc., at such institutions as the Universities of California, Cincinnati, Illinois, Texas, Penn State, and others, testify to this. Also, in response to the Secretary of the Interior, the industry has announced that it will continue to seek suitable replacements for phosphates in detergent products, although candidly it holds forth little hope for finding such new materials since they have been sought for performance reasons for over 20 yr, without success. Nevertheless, the industry will continue to do its part whenever possible, and will hope to make a real contribution toward solving the overall eutrophication problem.

Webb, S.J.

Factors Affecting the Viability of Air-Borne Bacteria.
I: Bacteria Aerosolized from Distilled Water.

Journal of Canadian Microbiology. 5:649-669. December 1959.

Key Words: bacteria, air.

Abstract:

The death of bacterial cells aerosolized from distilled water suspensions has been studied over a 5-hour period. It was found that death occurred in two stages, a rapid initial kill taking place within the first second and a subsequent slower death. First-order kinetics only applied to this secondary death at low relative humidity ranges, and this is taken to indicate that at least two reactions are responsible for viable decay. The death rates of the air-borne cells have been correlated with a mathematical function of both temperature and humidity. Activation energies associated with aerosol death have been found to increase from 4000 cal/mole to 12,000 cal/mole as the cells age in air. It is suggested that the death of the cell results from the movement of water molecules in and out of the cell, in an equilibrium system, resulting in a collapse of the natural structure of cellular protein.

Webb, S.J.

Factors Affecting the Viability of Air-Borne Bacteria.
II: The Effect of Chemical Additives on the Behavior of Air-Borne Cells.

Journal of Canadian Microbiology. 6:71-88. January 1960.

Key Words: bacteria, air.

Abstract:

The effect on air-borne cells of single chemical compounds added to a bacterial suspension prior to atomization has been studied. It has been found that some amino acids, long chain protein degredates, some sugars and polyhydroxycyclohexanes can enhance the survival of air-borne cells. The ability of a compound to preserve viability during periods of desiccation has been found to be connected with the presence of an amino and/or secondary alcohol group. For maximal protection these groups need to be substituted onto a six-membered ring nucleus. The hydroxyl group has been found toxic if present on a benzene ring, but protective on a pyrimidine ring. Inositol was found to afford a large measure of stability to the air-borne cells and its stabilizing ability could be destroyed by urea and guanidine. It is suggested that compounds enhance survival by replacing water molecules in protein structure during desiccation through hydrogen bonding and so preserve the natural structure of the cellular proteins. Peaks in death rates at intermediate relative humidity levels have been found to be due to the presence of the added compounds.

Webb, S.J.

Factors Affecting the Viability of Air-Borne Bacteria. III: The Role of Bonded Water and Protein Structure in the Death of Air-Borne Cells.

Journal of Canadian Microbiology. 6:89-105. January 1960.

Key Words: bacteria, air.

Abstract:

The relationship between cellular water and the death of air-borne cells, and the effect of added substances on these relationships, has been studied. The rate of death of air-stored cells has been correlated with the amount of water bonded to the cellular proteins. Refractive indices of cells, measured by light scatter and interferometry, have suggested that cells suspended in solutions of various compounds contain less water. With the exception of urea, the more able a compound is in displacing water, the less its protectiveness to air-borne cells. Inositol produced the smallest change in the water content and refractive index of cells. This is taken to indicate that, in the absence of water, this compound can form hydrogen bonds with cellular protein which are reversible with water. There appears also to be some relationship between the Gram stain reaction and aerosol stability of the cells. Ribonuclease and lysozyme treatment of air-stable cells rendered them air sensitive, whereas resistance to some antibiotics, and suspension in some antibiotics, afforded stability to air-sensitive cells. It is suggested that the site of damage is the cellular "membranes" which break down on desiccation and result in a loss of differentiation within the cell.

Weber, W.J. and J.C. Morris.

Equilibria and Capacities for Adsorption on Carbon.

Journal of the Sanitary Engineering Division,
ASCE. 90(SA3):79-107. June 1964.

Key Words: synthetic/organics, adsorption/ion exchange.

Abstract:

Although rates of uptake of organic solutes by granular carbon in nonflow systems previously have been shown to be quite low, the research reported herein has demonstrated that the ultimate capacity is great, on the order of 25 percent by weight for adsorption of materials such as nitrochlorobenzene and approximately 15 percent by weight for adsorption of high molecular weight sulfonated alkylbenzenes on the experimental carbon. Capacities on this order of magnitude are considerably greater than normal capacities realized for powdered carbon used presently (1964) for water treatment, because a standard phenol value of 30 means adsorption of 90 micrograms of phenol by 30 milligrams of carbon, or approximately 0.3 percent by weight. Furthermore, high capacities have been observed for quite low concentrations of solute -- approximately 3 micromoles per liter, or about 1 milligram per liter -- for surfactants of high molecular weight.

Weber, W.J., Jr. and L.H. Ketchum, Jr.

Activated Silica in Wastewater Coagulation.

University of Michigan, Ann Arbor, College of Engineering.
June 1974. 168p. (Available from National Technical
Information Service (NTIS) as PB-232 454).

Key Words: phosphates, chemical treatment.

Abstract:

The role of activated silica in coagulation of wastewaters with lime was examined. Laboratory studies were conducted on synthetic wastewaters to simulate certain wastewater characteristics and verification studies were conducted on samples of natural waters and wastewaters. For high alkalinity wastewaters activated silica provides no substantial benefit; reasons for the loss of effectiveness are discussed. For low alkalinity wastewaters however, significant (3 to 10-fold) reduction in lime requirement is possible; the addition necessary to accomplish this lime reduction is small, 2 to 4 mg/l as SiO_2. In low alkalinity wastewaters high in phosphate concentration (approximately 7 mg/l as PO_4) coagulation is accomplished with low lime addition only; multinuclear silica is as effective and in most cases more effective than activated silica. This treatment scheme may provide a convenient method of treating storm and combined sewer discharges which are commonly low in alkalinity.

Weber, W.J., Jr., C.B. Hopkins, and R. Bloom, Jr.

Physicochemical Treatment of Wastewater.

JWPCF. 42(1):83-99. January 1970.

Key Words: BOD, total organic carbon, chemical treatment, adsorption/ion exchange.

Abstract:

A physicochemical coagulation/adsorption process for direct treatment of wastewater has been developed and field tested for a 1-yr period in a pilot facility treating approximately 7,200 gpd (27.3 cu m) of wastewater. The concept of applying physicochemical treatment directly to a primary wastewater, rather than to a water which has undergone biological secondary treatment, represents a significantly different concept in the application of advanced processes for wastewater treatment.

Consistent TOC and BOD removals of 95 to 97 percent have been maintained, despite variations in waste strength and composition. Toxic substances which adversely affect biological treatment processes have little or no effect on the physicochemical process. The effluent produced by the physicochemical process is essentially free of suspended solids and contains only about 5 mg/l or less of TOC and BOD, compared with average TOC and BOD values of about 30 to 35 mg/l for the same wastewater when treated conventionally.

In addition, the physicochemical treatment process generally achieves a high degree of removal of phosphate (about 90 percent) and nitrate (about 95 percent), inorganic algal nutrients which normally are not removed effectively by conventional biological wastewater treatment.

Preliminary cost estimates, based on published cost figures derived from statistics on actual plants, have indicated that this high degree of treatment is achieved at reasonable cost. Physicochemical treatment of an average municipal wastewater to produce an effluent quality sufficient to meet most demands for reuse and for control of receiving water pollution may cost about \$0.16/1,000 gal (3.8 cu m), including amortization of the capital. On a comparable basis, conventional primary-secondary biological

treatment, which can achieve only about 80 to 90 percent organic removal and little or no nutrient removal, costs about \$0.11/1,000 gal (3.8 cu m). If tertiary treatment is added to the latter to achieve the same high degree of treatment achieved in the physicochemical process described here, the total cost is estimated to be \$0.26/1,000 gal (3.8 cu m). A factor which does not appear in these figures, but which should be pointed out, is that the physicochemical process would occupy only about 25 percent of the land area required by a biological treatment plant of the same capacity.

Another significant advantage of the physicochemical treatment system is flexibility afforded in plant design, relative to both plant capacity and to degree of treatment. The physicochemical process permits plant design for modular additions to accommodate growth in size as well as to accommodate increasing requirements for effluent quality. For example, an effluent quality comparable to that obtained from an activated sludge process can be achieved with a carbon adsorption system providing a relatively brief carbon contact period; as requirements for improved effluent quality develop, additional adsorption units simply can be added to provide more contact time, and more effective removal of organic material. Similar flexibility is provided with respect to removal of suspended matter by coagulation and filtration, and removal of phosphates by precipitation.

It is anticipated that results similar to those reported here will be achieved readily in larger plants scaled up from the pilot plant. It appears desirable now to demonstrate the effectiveness of this type of treatment on a scale of 0.5 to 1 mgd (1,892 to 3,785 cu m) to obtain final criteria for design of physicochemical treatment plants of any desired size.

Wei, I.W. and C. Morris.

Dynamics of Breakout Chlorination.

In: Chemistry of Water Supply, Treatment, and Distribution.
J. Rubin, ed. Ann Arbor Science Publishers, Ann Arbor,
Michigan, 1975. pp. 297-332.

Key Words: chlorination.

Abstract:

In order to understand properly the dynamics and the mechanism of the breakpoint process, it is essential to have detailed information about its time course, that is, about the rate of reduction of chlorine (loss of oxidizing chlorine) and about the formation and reaction of various chloramines.

In an attempt to elucidate major aspects of kinetics and mechanism, this work focused on the dynamics of the process during the first hour or so. No attempt was made to cover the broad pH ranges and the chlorine to nitrogen ratios dealt with by others. Only pH values near neutrality and the maximum rate of the breakpoint process, and the chlorine to nitrogen ratios close to that of the breakpoint itself were investigated.

Wei, I.W., R.S. Engelbrecht, and J.H. Austin.

Removal of Nematodes by Rapid Sand Filtration.

Journal of the Sanitary Engineering Division, ASCE.
95(SA1):1-16. February 1969.

Key Words: parasitic worms, filtration.

Abstract:

From laboratory experiments on the removal of nematodes by rapid sand filtration, the following conclusions may be drawn:

1. The removal of nematodes was about 96% regardless of sand size when all the nematodes in the influent were dead or nonmotile.

2. When all the nematodes in the influent were dead or nonmotile, the percent removal of nematodes was constant over an entire filtration period of 16 hr with a nematode concentration in the influent as high as 50 nematodes per l.

3. A breakthrough of nonmotile nematodes when only nonmotile nematodes were present was not found at concentrations less than 50 per l.

4. The penetration of nonmotile nematodes increased as the hydraulic resistance of the filter sand decreased.

5. The motility of nematodes had a much more significant effect than sand size upon the percent removal of nematodes by rapid sand filtration.

6. Most motile nematodes could eventually penetrate the filter bed although they were temporarily retained in the filter bed during the early stages of filtration.

7. Motile nematodes appeared to cause dislodgment of a significant fraction of the nonmotile nematodes initially removed by the filter.

8. Sands with higher hydraulic resistance and the use of chemical pre-treatment methods could reduce the dislodging effect of motile nematodes providing the percentage of motile nematodes was low.

9. The predominant factor in determining the percent of nematode removal was the percent motile nematodes

in the influent, regardless of sand size.

10. The removal of nematodes decreased as filtration time increased until an equilibrium was reached. This was due to the penetration of motile nematodes and dislodging of nonmotile nematodes by motile nematodes.

Weibel, S.R., R.B. Weidner, A.G. Christianson, and R.J. Anderson.

Characterization, Treatment, and Disposal of Urban Stormwater.

Advances in Water Pollution Research. 1966(1): 329-352.

Key Words: suspended solids, COD, BOD, coliforms, chlorides, surface water (fresh).

Abstract:

1. Increasing population, urbanization, and demands on water resources require increased efforts to conserve, cleanse, and reuse available water and force attention to pollution from land runoff and rainfall.

2. This study indicated that inorganic nitrogen and hydrolyzable phosphate in rainfall average 0.69 mg/l. and 0.24 mg/l., respectively; both exceed SAWYER's threshold levels for algal blooms. Organic chlorine content in rainfall averaged 0.28 g/l. DDT, DDE, and BHC have been identified in rainfall at Cincinnati.

3. Study of stormwater runoff from a 27-acre (11-ha) residential and light-commercial urban area indicated the following constituent averages: suspended solids, 227 mg/l.; volatile suspended solids, 57 mg/l.; COD, 111 mg/l.; BOD, 17 mg/l.; inorganic nitrogen, 1.0 mg/l.; total hydrolyzable phosphate, 1.1 mg/l.; and organic chlorine, 1.70 g/l. Some or all of these could be of significance, depending on the environment.

4. Constituent loads in the urban runoff mentioned above, calculated both on an annual basis and on the basis of daily discharges during storms, and compared with sanitary sewage production at a 9-person/acre (22-person/ha) population density, indicated that the pounds (kg) of suspended solids discharged annually in the runoff equal 160 percent of those produced as sanitary sewage; COD, 33 percent; BOD, 7 percent; total hydrolyzable phosphate, 5 percent; and total nitrogen, 14 percent. During runoff, stormwater runoff constituent discharge rates, expressed as percentages of average raw sewage constituent production rates at the same population density mentioned above, are: suspended solids, 2,400 percent; COD, 520 percent; BOD, 110 percent; total hydrolyzable phosphate, 70 percent; and total nitrogen, 200 percent.

5. Coliform, fecal coliform, and fecal streptococcus tests were made on the urban runoff samples. Coliform densities were greater than 2,900/100 ml in 90 percent of the samples, exceeding the 1,000/100 ml criterion for swimming-water quality in use in many places in the United States.

6. In a few exploratory laboratory tests on urban runoff samples, settling only for 10 or 20, and more minutes did not remove suspended solids and BOD effectively.

7. Results from laboratory concurrent 20-min settling-chlorine-contact experiments on urban runoff from one storm on the same watershed show that kills of better than 99.999 percent for coliforms and fecal coliforms and 99.99 for fecal streptococci were obtained at a 4.62-mg/l. chlorine dose. There was after-growth of coliforms in dechlorinated samples held 24, 48, and 72 hr at room temperature, but substantially no growth of fecal coliforms and fecal streptococci at and beyond the 4.62-mg/l. dose (including 18.46 mg/l., the highest dose tried). This work is being continued.

8. The sandy soils on Long Island, New York, are used as recharge basins for stormwater disposal. These basins, which are cheaper than long, artificial conduit systems in flat terrain, are used to dispose of road drainage, dwelling project stormwater runoff, industrial stormwater runoff, and treated wastewater.

9. Because of the increasing needs for conservation and effective use of all available water resources, urban stormwater, not necessarily "running off", must play an important role as a readily available raw water resource. This study indicates that in many cases this water may require manipulation and modification in character before it is acceptable for the many and varied beneficial uses to which it can be put.

Weibel, S.R., R.B. Weidner, A.G. Christianson, and R.J. Anderson.

Characterization, Treatment, and Disposal of Urban Stormwater.

Munich Abstracts - Section I. 38(3):337-338. March 1966.

Key Words: BOD, COD, suspended solids, phosphates, combined municipal and/or storm system.

Abstract:

Studies on stormwater runoff from a residential-light commercial urban area in Cincinnati over a year's time indicated BOD's ranging up to 84 mg/l, COD's to 610 mg/l, suspended solids to 1,200 mg/l, total nitrogen to about 10 mg/l, and total soluble phosphate to 4.3 mg/l. Organic chlorides were as high as 2.7 mg/l.

Weibel, S.R., R.B. Weidner, J.M. Cohen, and A.G. Christianson.

Pesticides and Other Contaminants in Rainfall and Runoff.

JAWWA. 58(8):1075-1084. August 1966.

Key Words: pesticides, DDT, BOD, COD, ammonia, nitrates, nitrites, phosphates, coliforms, groundwater.

Abstract:

Rain is an efficient means in the natural global cleaning process by which gases and particulates in the atmosphere are brought to earth. As rainwater reaches surface either as runoff or seepage, or directly, as on a lake, its quality is significant in pollution control.

Although considerable reporting has been done on rainfall analyses for minerals, very little appears to have been done on pesticides.

Water quality control and conservation research should generate answers to questions on the quality of rainfall and runoff and the significance of contaminants contained therein. Multiple benefits in water conservation, lower stormwater peak flows, and water pollution control are involved.

Weidenkopf, S.J.

Inactivation of Type 1 Poliomyelitis Virus with Chlorine.

Virology. 5(1):56-67. 1958.

Key Words: polio virus, chlorination.

Abstract:

The rate of inactivation of type 1 poliovirus was studied as a function of free available chlorine and hydrogen ion concentration at 0°. Highly purified poliovirus suspensions were used to hold chlorine losses to insignificant level. Results indicated that under the experimental conditions employed, the same general theories which are useful in explaining inactivation of other microorganisms also apply to type 1 poliomyelitis and the rate of inactivation is independent of the virus concentration.

Weidner, C.W.

Degradation in Groundwater and Mobility of Herbicides.

University of Nebraska, Lincoln, Department of Agronomy, June 1974. 77p. (Available from National Technical Information Service (NTIS) as PB-239 242).

Key Words: herbicides, direct contact, groundwater.

Abstract:

Laboratory studies were conducted to determine the degradation rates for atrazine, alachlor, butylate and picloram stored in groundwater. A significant amount of herbicide degradation occurred over the duration of the experiment. The rate of degradation was dependent on chemical properties of the herbicide, concentration, storage temperature and to a lesser extent the source of the water samples. Butylate showed the largest amount of degradation followed by alachlor, atrazine and picloram respectively. The 0.072 and 0.72 ppmw concentration samples result in more degradation than the 10 ppmw concentration samples. The samples stored resulted in more degradation than the samples stored at 10C. Water samples from the Clay Center location showed more herbicide degradation than the other three water sources. While herbicide degradation in groundwater did occur, the rate was much slower than would be expected for the same herbicides in a soil medium.

Weidner, R.B., A.G. Christianson, S.R. Weibel, and G.G. Robeck.

Rural Runoff as a Factor in Stream Pollution.

JWPCF. 41(3):377-384. March 1969.

Key Words: BOD, COD, coliforms, surface water (fresh).

Abstract:

The results of this work indicate that rural runoff is a factor in stream pollution and that it must be considered when one evaluates the quality of any stream or receiving body of water. However, there also must be an awareness that there are some means available for reducing this pollutional load. This study showed that, despite an increase in the amount of fertilizers and manure applied under improved practices, there was a marked decrease in the amount of pollutional load that came from these watersheds as contrasted to the load from watersheds using prevailing practice.

Wellings, F.M., A.L. Lewis, and C.W. Mountain.

The Demonstration of Solids-Associated Virus in Wastewater and Sludge.

Epidemiology Research Center, State of Florida Division of Public Health, Tampa, Florida, 1975. 14p.

Key Words: viruses, effluent characteristics, anaerobic digestion.

Abstract:

Data presented demonstrate the relatively high multiplicity of solids-associated virus in field samples, i.e., wastewater, sludge and soils. Influent, effluent and chlorinated effluent samples showed 16.1% to 100% of the total virus demonstrated in samples to be solids-associated. Three techniques for freeing solids-associated virus are described and compared. Utilizing sonication of solids and polyethylene glycol concentration, virus was demonstrated in fully digested sludge (60 days at 34°C), sand at the site of a sewer leak, dried sludge cake and mud 900 meters downstream from a sewage disposal site. These data emphasize the inadequacy of virus concentration techniques which do not include the processing of solids. In-situ elution failed to free solids-associated virus.

Wellings, F.M., A.L. Lewis, C.W. Mountain, and L.V. Pierce.

Demonstration of Virus in Groundwater after Effluent Discharge onto Soil.

Applied Microbiology. 49(6):751-757. June 1975.

Key Words: viruses, direct contact.

Abstract:

The survival of virus present in secondary effluents discharged into a cypress dome was studied. Isolations were made from concentrates of water drawn from 10-foot (304.80 cm) deep wells. Data presented show vertical and lateral virus movement as well as survival within the dome for 28 days during a period of heavy rains when no effluent was being applied. Due to the inefficiency of virus concentration procedures, it is proposed that much of the virus present was probably not demonstrated. A rapid, relatively inexpensive concentration technique for sewage influents and effluents is discussed.

Wellings, F.M., C.W. Mountain, A.L. Lewis, J.L. Nitzkin, M.S. Saslaw, and R.A. Graves.

Isolation of an Enterovirus from Chlorinated Tap Water. Personal Communication. 1975.

Key Words: viruses, surface water (fresh), drinking and recreational water.

Abstract:

An outbreak of enterovirus disease occurred in a migrant labor camp in Dade County, Florida, in March, 1975. Epidemiological evidence amassed by Dade County Department of Public Health personnel appeared to indicate that cases resulted from a common source. One of the ten 100 gallon samples of suspect potable water tested for virus yielded an ECHO 22/23 complex. This agent was also isolated in cell culture from two of 23 stools tested. Three additional stool isolates, a Coxsackie A6 and two Coxsackie A2's, were made in newborn mice.

Six weeks later, a hepatitis outbreak occurred and presented an epidemic curve which could be superimposed on that of the shorter incubation period enterovirus outbreak. None of the Coxsackie A's identified could have been detected in the cell line used for assaying all water samples, so their presence in the tested waters would have gone undetected.

Water supplied by this private utility company is drawn from wells located in the center of an area served by septic tanks and is chlorinated before entering the distribution lines. Combined chlorine of the water tested ranged from 0.4 to 0.6 ppm.

Wellings, F.M., A.L. Lewis, and C.W. Mountain.

Pathogenic Viruses May Thwart Land Disposal.

Water and Wastes Engineering. 12:70-74. March 1975.

Key Words: viruses, groundwater.

Abstract:

This article is a general write-up of viral problems of land disposal; no data is presented.

Wellings, F.M., A.L. Lewis, and C.W. Mountain.

Virus Survival Following Wastewater Spray Irrigation of Sandy Soils.

Epidemiology Research Center, State of Florida, Tampa, Department of Health and Rehabilitative Services, 1974.

Key Words: viruses, ponding/land application.

Abstract:

An important aspect of this study is the use of PEG for virus concentration. This method brings the monitoring of effluents within the purview of any laboratory. No expensive equipment or particular expertise is required for concentrating viruses by this method. The concentrate could readily be shipped to a virus laboratory equipped to isolate and identify viruses, extending to the sanitary engineer the expertise of the limited number of virus laboratories in the nation. At the moment, there is on-going work on a design to permit the use of PEG for concentrating up to 30-gallon samples which, based on the percent efficiency demonstrated, would be comparable to MA concentration of 50-100 gallons.

Wellings, F.M., A.L. Lewis, and C.W. Mountain

Virus Survival Following Wastewater Spray Irrigation of Sandy Soils.

In: Virus Survival in Water and Wastewater Systems. J.F. Malina, Jr. and B.P. Sagik, ed. University of Texas at Austin, Center for Research in Water Resources, 1974. pp. 253-260.

Key Words: viruses, ponding/land application.

Abstract:

These studies have confirmed the findings of others which have shown that secondary wastewater treatment processes including chlorination do not provide a virus free effluent. More importantly, these studies have shown that virus does survive aeration and sunlight during spraying and percolation through 10 to 20 feet of sandy soil. Various possibilities have been considered in an attempt to explain the positive deep well findings. The most obvious would be the loss of integrity of the wells. Major factors mitigating against this are the variation in pH and buffering capacity of the well waters. The pH of water in the 5-foot wells ranges from pH = 6.6 to pH = 7.4, in 10-foot wells from pH = 3.5 to pH - 4.0 and in the 20-foot wells from pH = 6.4 to pH = 6.8. Based on these data, integrity of the 10-foot well could not be questioned. The similarity between the pH of the 5- and 20-foot wells is open to speculation. However, when the buffering capacity of the waters is considered, one must assume that waters at 5- and 20-foot levels are not comparable. To achieve pH = 3.5 necessary for membrane filtration, the quantity of acid required in 50 gallons of water from the 5-foot well is approximately 55 ml of 12N HCl as opposed to 75 ml of 12N HCl in 50 gallons from the 20-foot well.

Secondly, if there were a communication between surface and deep waters, one would anticipate frequent positive findings as opposed to the burst of virus demonstrated. Also, a mixed virus population such as is found in the chlorinated specimens would be expected. As has been shown, the virus burst in both the 10- and 20-foot wells was all polio type 1, which suggests that this virus may be more stable in the terrestrial environment or may have been selectively desorbed.

It is generally accepted that the soil/water ratio is of prime importance in virus adsorption to soil particles. Following the heavy rains (28 inches) in July, August, and September, the soil was saturated, resulting in an exceedingly high soil/water ratio. It is proposed that

this led to increased solubility of select portions of the organic layer and probably additional desorption of attached virus. As the waters began to recede these solutes and the desorbed virus resulted in filtration difficulties and the virus burst demonstrated in the 10-foot well. Once virus has passed the organic layer there would be no reason to anticipate resorption since they would then be in a high water/soil ratio zone. It would be anticipated that the virus present would move freely downward as the waters receded. This may explain the decreasing virus contamination of the 20-foot well noted six days after the virus burst in the 10-foot well. If the same phenomenon is observed following another period of heavy rainfall, our theory will be verified and would necessitate a re-evaluation of the ultimate dangers of aquifer contamination over time from wastewater spray irrigation.

A second important aspect of this study is the use of PEG for virus concentration. This method brings the monitoring of effluents within the purview of any laboratory. No expensive equipment or particular expertise is required for concentrating viruses by this method. The concentrate could readily be shipped to a virus laboratory equipped to isolate and identify viruses, extending to the sanitary engineer the expertise of the limited number of virus laboratories in the nation. There is work at the moment on a design to permit the use of PEG for concentrating up to 30-gallon samples which, based on the percent efficiency demonstrated, would be comparable to MA concentration of 50-100 gallons.

, C. and A.H. Molof.

crification in the Biological Fixed-Film Rotating Disk System.

PCF. 46(7):1674-1685. July 1974.

ey Words: ammonia, nitrites, nitrification/denitrification, rotating biological disk.

stract:

The BFFRD system is an efficient treatment unit for nitrification.

Increasing flow rate at a constant influent concentration decreased the nitrification efficiency of the BFFRD reactors.

Decreasing detention time from 96 min to 24 min per stage, by varying flow and influent concentration at a constant organic and ammonia-nitrogen loading had no significant effect on the nitrification efficiency of the BFFRD reactors.

Decreasing detention time from 48 min to 17 min per stage by varying reactor volume at a constant organic and ammonia-nitrogen loading had no significant effect on the nitrification efficiency.

Increasing influent concentration at a constant flow resulted in a decrease in nitrification efficiency.

Increasing the disk surface area increases the nitrification efficiency.

Increasing liquid temperature from 20.7° to 29.3°C increased the nitrification efficiency.

Increasing the rotational disk speed increased the nitrification efficiency.

The rotational direction of the disks has some effect on the nitrification efficiency; counter-current direction gives somewhat higher efficiency than does co-current direction.

The submerged disk depth had little if any effect on the nitrification efficiency of the reactors, provided that the whole disk surface was covered with a film of wastewater.

Wentink, G.R. and J.E. Etzel.

Removal of Metal Ions by Soil.

JWPCF. 44(8):1561-1574. August 1972.

Key Words: chromium, copper, zinc, land reclamation, ponding/land application.

Abstract:

Exchange capacity of the three soils tested increased as the clay mineral content increased and the particle size decreased.

Complete removal of chrome was possible up to concentrations of 300 mg/l with any of the soil types tested.

Removal of copper was complete after an initial conditioning period for any of the three soil types tested.

Removal of zinc at application rates as high as 300 mg/l can be accomplished with an efficiency of not less than 99.7 percent.

Mass-action effect was observable for all soil types tested when the chrome, copper, or zinc was applied individually.

Removal of metal ions by the three soil types tested was accomplished by an ion exchange mechanism.

Regeneration of the three soil types tested was found to be possible.

Leachability of the exchanged ions in the soil types tested was essentially non-existent when either tap water or deionized water was used as the leachate.

Wesner, G.M. and D.C. Baier.

Injection of Reclaimed Wastewater into Confined Aquifers.

JAWWA. 62(3):203-210. March 1970.

Key Words: chlorides, ammonia, nitrates, nitrites, phosphates, COD, iron, manganese, boron, lead, effluent characteristics, groundwater, trickling filter, ponding/land application.

Abstract:

One barrier against seawater intrusion into an aquifer is a line of barrier injection wells several miles inland, with pumping wells between them and the shoreline. Treated wastewater offers a supply of injection water, and research reveals how it flows, changes in composition, and otherwise behaves in the aquifer surrounding the injection well.

Westing, A.H.

Ecocide: Our Last Gift to Indochina.

Environmental Quality. 4(5):36-42, 62-65. May 1973.

Key Word: herbicides.

Abstract:

In this article the author describes the major programs that he feels will make the Second Indochina War go down in history as the first anti-environmental war: the effects of bombing, the resulting craterization as well as chemical warfare with herbicides, etc.

Weston, R.F., J.E. Germain, and M.E. Fiore.

Solving the Combined Sewer Overflow Problem of a Major City.

Public Works. 103(5):106-108. May 1972.

Key Words: BOD, phosphates, ammonia, nitrates, suspended solids, combined municipal and/or storm system.

Abstract:

This paper gives data on the parameters (general) in combined and separate storm sewers.

Whetstone, G.A.

Re-Use of Effluent in the Future,with an Annotated Bibliography.

Texas Water Development Board, Austin, Texas, 1965. 187p.

Key Words: surface water (marine), drinking and recreational water.

Abstract:

This report cautions about possible adverse health effects from the future use of sewage effluent for recreational uses.

White, A.W., A.P. Barnett, B.G. Wright, and J.H. Holladay.

Atrazine Losses from Fallow Land Caused by Runoff and Erosion.

Environmental Science and Technology. 1(9):740-744.
September 1967.

Key Words: herbicides, surface water (fresh).

Abstract:

From present information concerning toxicity levels of this herbicide, concentrations of the above magnitude probably would not constitute a serious pollution hazard to fish or wildlife. Rats fed daily for 2 years with food containing 200 ppm atrazine were comparable in every respect to controls. Other tests have shown that the minnow (Phoxinus phoxinus) is unharmed when exposed to atrazine concentrations of 0.5 ppm for 48-hr periods. On the other hand, the long-term impact of pesticide residues upon biological systems is not well understood, and the possibility exists that subtle effects not readily apparent may exist. A detailed discussion of this subject is beyond the scope of this paper.

In actual practice, a number of factors will influence the amount of atrazine appearing in washoff, and losses could vary from those reported in this paper. The recommended application rate of atrazine (3 pounds per acre) was used in this study. Greater losses would be expected if higher rates were used. Storm size and intensity and soil temperature conditions will influence the degree of loss. Also, erosion and runoff will vary with different soils and slopes.

The results from this study indicate that atrazine is transported in small but significant amounts in washoff from field plots of Cecil sandy loam. At recommended application rates of this herbicide and under field and rainfall situations most likely to be encountered, atrazine losses in washoff from soils and slopes similar to those of this study would be expected to occur most commonly in amounts of less than 0.1 pound per acre in the first storm after the herbicide application. Losses in subsequent storms should be progressively less than this amount.

White, G.C.

Disinfecting Wastewater with Chlorination/Dechlorination.Part I.

Water and Sewage Works. 121(8):70-71. August 1974.

Key Words: coliforms, chlorination.

Abstract:

This report discusses chlorination chemistry and mathematics.

White, G.C.

Disinfection Practices in the San Francisco Bay Area.

JWPCF. 46(1):87-101. January 1974.

Key Words: coliforms, chlorination.

Abstract:

Mixing is of major importance to good disinfection performance, and because it is not adjustable, the mixing device must be well planned.

Proper mixing allows maximum performance with a minimum amount of chlorine.

The higher the chlorine demand, the more efficient must be the mixing, other things being equal.

The data indicate that the optimum dosage for disinfection of domestic wastewater not allowing for industrial waste or other constituents causing abnormal chlorine demands is usually between 10 and 15 mg/l. One plant with an ideal system uses a dose between 3.5 and 4.5 of chlorine.

The optimum residual (measured amperometrically) with adequate mixing such as in a hydraulic jump seems to be between 3 to 4 mg/l with not less than 30 min contact time.

It seems not only possible but practical to disinfect a primary effluent.

The quality of the effluent is not of paramount importance in achieving disinfection.

Contact time should not be less than 30 min for any molecule of water passing through the contact chamber.

White, R.L. and T.G. Cole.

Dissolved Air Flotation for Combined Sewer Overflows.

Public Works. 104:50-54. February 1973.

Key Words: suspended solids, BOD, COD, ammonia, nitrates, combined municipal and/or storm system.

Abstract:

The City and County of San Francisco developed a comprehensive program for control of wet weather flows. The program consisted of design, construction, operation, and evaluation of a demonstration dissolved air flotation facility for the treatment of combined sewer overflows.

Wiley, B.B. and S.C. Westerberg.

Survival of Human Pathogens in Composted Sewage.

Applied Microbiology. 18:994-1001. December 1969.

Key Words: salmonella, polio virus, fungal organism, composting.

Abstract:

Studies were conducted to assess the effectiveness of an aerobic composter in destroying pathogens that may possibly be present in raw sewage sludge. Experiments conducted in this study were designed to determine whether or not selected indicator organisms (i.e., *Salmonella newport*, poliovirus type 1, *Ascaris lumbricoides* ova, and *Candida albicans*) could survive the composting process. The results of the assay showed that after 43 hr of composting, no viable indicator organisms could be detected. The poliovirus type I was the most sensitive, being inactivated within the first hour, whereas *C. albicans* was the most resistant, requiring more than 28 hr of composting for its inactivation. The data from this study indicated that aerobic composting of sewage sludge would destroy the indicator pathogens when a temperature of 60 to 70 C is maintained for a period of 3 days.

Wilhelmi, A.R. and R.B. Ely.

A Two-Step Process for Toxic Wastewaters.

Chemical Engineering. 83(4):105-109. February 16, 1976.

Key Words: DDT, antibiotics, BOD, COD, wet air oxidation, trickling filter.

Abstract:

A combination of wet-air oxidation and biological treatment in the presence of powdered carbon has demonstrated an ability to handle chemical wastes.

Wilhelmson, G.

Polychlorinated Biphenyls, Occurrence and Degradation.

Pesticide Abstracts. 75:1808. 1975.

Key Words: chlorinated hydrocarbons, chlorination.

Abstract:

Studies and facts on the occurrence, migration, and degradation of PCB's in the environment are reviewed. The acute toxicity, being rather moderate, decreases with the increase of the rate of chlorination in some animal species, and increases in others. Contamination of the atmosphere, soil, and water bodies by PCB's is possible, while direct entrainment by animals is negligible. Because of their liposolubility PCB's, especially those with high chlorine content, accumulate in the environment and through the trophic chain, especially in aquatic organisms and ichthyophagous birds in which cumulation factors of up to 1,000,000,000 may be reached. While chemical degradation of PCB's in the environment is negligible, photolysis, especially of compounds with high chlorine contents, or dechlorination to compounds with reduced chlorine contents are highly probable. Excretion and metabolism of PCB's was observed in certain higher animals. Compounds with low chlorine content are subject to microbial degradation.

Wilkinson, H.F.

Movement of Micronutrients to Plant Roots.

In: Micronutrients in Agriculture. R.C. Dinauer, ed.
Soil Science Society of America, Madison, Wisconsin, 1972.
pp. 139-169.

Key Words: iron, manganese, zinc, copper, boron, ponding/land application, land reclamation, groundwater, crops.

Abstract:

It can readily be seen that our present understanding of the movement of micronutrients to roots is still rather qualitative. We need to understand much more clearly the boundary conditions and hopefully the concentrations of ions at the root surface. It is increasingly evident that the plant root itself provides H^+, chelating agents, reducing compounds, and substrates that build high concentrations of microorganisms and a whole host of their by products, all of which drastically modify the chemistry of the immediate rhizosphere. Many of these compounds produced by the root are particularly effective in mobilizing the micronutrient ions and increasing their subsequent flux to the root. The fact that exudation of some of these mobilizing materials is closely associated with deficiency concentration levels of particular micronutrients mobilized by the exudate suggests that some plant genotypes have developed response mechanisms that allow them to more efficiently extract micronutrients from soils deficient in these metals. This presents a more complex and challenging model than the simple physical models used in most past studies. Moreover, differences in exudation and micronutrient uptake efficiencies noted between varieties appear to offer a potential for solving many of our problems of mobilizing micronutrients by plant selection and breeding, as an alternative to chemical treatment of the soil. While this alternative might at first appear to be the exclusive domain of the crop breeders, examination of the specific procedures involved shows that a bsic understanding of plant soil interactions will be necessary to develop the screening techniques that are pre-requisites to efficient identification of stress-adapted plants.

Most soils contain adequate quantities of the micronutrients. The main limitation in micronutrient supply is usually movement of these tightly bound elements to the root surface. Fortunately, they may be mobilized by several types of organic chemicals. It appears that these chemicals may be supplied by direct addition to the soil, or by selection and breeding of varieties that manufacture these mobilizing agents.

Willenbrink, R.

Wastewater Reuse and Inplant Treatment

AIChE Symposium Series. 69(135):153-154. 1973.

Key Words: synthetic/organics, filtration, chemical treatment, adsorption/ion exchange.

Abstract:

Foul waters containing hydrogen sulfide, phenol and ammonia, spent phenolic and sulfidic caustic, and other soluble organic waste materials are generated within refineries. The way to improve effluent quality is in-plant reuse and recycling and treatment at the source. Methods are described.

Williams, J. and E.O. Bennett.

Biodegradation of Oleates.

JWPCF. 45(8):1671-1681. August 1973.

Key Words: oil and grease, manganese, surface water (fresh).

Abstract:

Oleates and hydroxyoleates, because of their uses in many commercial products, are potential hazards to environmental quality. The establishment of the degradability or nondegradability of these compounds is important because of their possible adverse effect on both environment and public health should they persist in nature while resisting biological decomposition. Because most of these compounds were found to be utilized by *P. aeruginosa* in the concentrations found in wastewater, it is safe to assume that in the near future the consumption of them will increase. This increase in usage will be a result of the fact that they do not cause pollution problems in reasonable concentration and that they are biodegradable substitutes for the non-oxidizable synthetic detergents or phosphate-containing detergents. The practicality of this research, then, lies in the fact that the degradability of oleic and hydroxyoleic acid salts and esters, which were potential pollutants, has been established, along with an efficient degrading soil organism, *P. aeruginosa*.

Williams, J.H.

Use of Sewage Sludge on Agricultural Land and the Effects of Metals on Crops.

Water Pollution Control. 74:635-644. 1975.

Key Words: zinc, copper, nickel, lead, cadmium, chromium, mercury, agricultural sludge disposal.

Abstract:

Care needs to be taken in the application of sewage sludge containing industrial waste from metal industries, as certain metals are toxic to crops. Those which are likely to prove toxic to plant growth are zinc, copper and nickel, and the high content of these metals in some sewages renders them entirely unsuitable for agricultural use. Once a harmful concentration of these toxic metals is built up in soils, the effect can be permanent. Zinc and nickel are absorbed by plant roots and are readily translocated within the plant, whereas copper tends to be concentrated in the roots. Crops vary greatly in their sensitivity to these metals but when considering safe threshold levels of metals for crop plants it is advisable to err on the side of safety since future cropping patterns may change.

There is little or no evidence that lead, cadmium or mercury adversely affects plant growth; however, these metals could be a health hazard if the crops consumed by animals or man have accumulated abnormal amounts of these metals. Lead is readily precipitated under neutral conditions (pH 6.5) and only a very small proportion of the total lead in soil is absorbed by plant roots. This absorbed lead is almost entirely retained in the roots. Cadmium is much more readily taken up by roots and distributed throughout the plant. Crops grown on soil treated with cadmium-fortified sludge accumulate substantial amounts of cadmium, therefore this element could constitute a health risk to animals which consume crops grown on land treated with cadmium contaminated sludge. Evidence is lacking on the behavior of mercury in soils but it is probably adsorbed on to organic matter and is not leached out very readily. It is taken up by roots but is not readily translocated into the aerial parts of the plant. The concentrations of mercury normally present in sewage sludge are not likely to give rise to hazardous concentrations in crops grown on sludge treated soil, but evidence is lacking on the behavior of both mercury and cadmium, and further studies are required.

Williams, L.G., J.C. Joyce, and J.T. Monk, Jr.

Stream-Velocity Effects on the Heavy Metal Concentrations.

JAWWA. 64(4):275-279. April 1973.

Key Words: copper, iron, mercury, zinc, cadmium, effluent characteristics, chlorination.

Abstract:

The study shows that heavy metals most often are associated with suspended and colloidal particles in significant concentration and that the relative concentration increases with bottom scours produced by heavy rains. These conditions may have several implications for the public health: first, these metals are concentrated by phytoplankters and are further concentrated by zooplankters feeding on phytoplankters. The latter are prey for filter-feeding fish, such as the threadfin shad, which is one of the principal food-chain organisms of bluegill and bass fishes. First, bluegills (also known as bream) in the Oliver and Warrior pools were found with mercury concentrations in their muscle tissues as much as four times the 5,000-ppb limit set by the U.S. Food and Drug Administration. Second, the decreased water quality enhances the domination of aquatic communities by dense nuisance populations of blue-green algae and slime bacteria. Third, the belief that dilution can be the solution to pollution is no longer valid, as many industrial concerns and their engineers have led the general public to believe. Fourth, this condition has led to the destruction of a favorable balance of microbes and plankton at low trophic levels, of which the general public has little or no comprehension.

Williams, T.C. and S.K. Malhotra.

Phosphorus Removal for Aerated Lagoon Effluent.

JWPCF. 46(12):2696-2703. December 1974.

Key Words: phosphates, chemical treatment, ponding/land application.

Abstract:

Pilot plant studies for phosphorus removal from aerated lagoon effluent indicated that a lime (CaO) dose of 150 mg/l with sludge recycle was as effective as a lime dose of 250 to 300 mg/l as CaO. The sludge obtained with a 150 mg/l lime dose had good settling characteristics and was estimated to be about 2.5 tons of dry solids mil gal (3.785 cu m) with above 15 percent volatile matter. The effluent pH with this lime did not warrant neutralization of the effluent before its discharge into surface waters.

The results of the pilot study have been used to design a 2.5-mgd (9,470 cu m/day) tertiary wastewater treatment facility with one shift operation. This facility can also provide effective treatment for combined wastewater flows up to 7.5 mgd (28,410 cu m/day) by the operation of chemical precipitation units for more hours on days following a rainfall.

The design requiring one shift operation has a number of advantages. These are: lower labor costs for operation; the ability to handle combined sewer flows, which reduces the urgency of complete separation; the possibility for future increase in design load with minimum additional capital expenditure; and the operation of chemical precipitation units at a uniform rate on any day, which results in a final effluent of uniform quality.

Wilson, T.E. and M.D.R. Riddell.

Nitrogen Removal: Where Do We Stand?

Water and Wastes Engineering. 11:56-61. October 1974.

Key Words: ammonia, nitrates, nitrites, nitrification/denitrification, adsorption/ion exchange.

Abstract:
This is a review of what nitrogen processes are and removal of nitrogen compounds thereof.

Windom, H.L.

Geochemical Interactions of Heavy Metals in Southeastern Salt Marsh Environments.

Skidaway Institute of Oceanography, Savannah, Georgia, March 1976. 46p. (Available from National Technical Information Service (NTIS) as PB-252 250).

Key Words: iron, manganese, cadmium, mercury, surface water (marine).

Abstract:

This report summarizes the results of a three year study of the transport, fate, and geochemical interactions of mercury, cadmium, and other inorganic pollutants in the southeastern coastal littoral-salt marsh environment. The general objectives of the study were to determine: 1) the rate of input of these materials to salt marsh estuaries, 2) the geochemical interaction they experience there and, 3) their ultimate fate in coastal littoral waters.

Windom, H.L.

Mercury Distribution in Estuarine-Nearshore Environment.

Journal of the Waterways, Harbors, and Coastal Engineering Division, ASCE. 99:257-265. May 1973.

Key Words: mercury, surface water (fresh), surface water (marine).

Abstract:

This article discusses mercury transport through estuarine environment to open waters including diagramming an estuarine system. Data includes mercury in nearshore waters, plant uptake, and sedimentation loss.

Wing, R.E.

Corn Starch Compound Recovers Metals from Water.

Industrial Wastes. 21(1):26-27. January/February 1975.

Key Words: copper, nickel, cadmium, lead, chromium, zinc, iron, manganese, mercury, chemical treatment.

Abstract:

A corn starch compound, insoluble starch xanthate, offers industry a new way to recover metals dissolved in water. Recovering expensive metals at industrial plants permits their reuse, conserves them as limited natural resources, and reduces dangers of toxic levels in public water supplies and city sewage sludge.

Wing, R.E., C.L. Swanson, W.M. Doane, and C.R. Russell.

Heavy Metal Removal with Starch Xanthate-Cationic Polymer Complex.

JWPCF. 46(8):2043-2047. August 1974.

Key Words: cadmium, chromium, copper, lead, iron, manganese, mercury, nickel, zinc, chemical treatment.

Abstract:

Wastewater containing heavy metals must be treated before being discharged. The starch xanthate-PVBTMAC method presented will remove most heavy metals to below Illinois discharge limits with a single treatment. Cd^{2+}, Cr^{3+}, Cu^{2+}, Pb^{2+}, Hg^{2+}, Ni^{2+}, and Ag^{+} are essentially completely removed. Considerable amounts of Fe^{2+}, Mn^{2+}, and Zn^{2+} are removed at large initial concentrations, but residual levels exceed Illinois effluent limits. Several variables in the xanthate method may be changed to improve heavy metal removal.

Wing, R.E., W.M. Doane, and C.R. Russell.

Insoluble Starch Xanthate: Use in Heavy Metal Removal.

Journal of Applied Polymer Science. 19:847-854. 1975.

Key Words: copper, nickel, cadmium, lead, chromium, silver, zinc, iron, manganese, mercury, chemical treatment.

Abstract:

Water-insoluble starch xanthates were prepared by xanthation of highly crosslinked starches under various conditions. After isolation of the products by solvent dehydration, freeze drying, or spray drying, their properties were determined. These products were very effective in removing heavy metals from water.

Winton, E.F., R.G. Tardiff, and L.J. McCabe.

Nitrate in Drinking Water.

JAWWA. 63(2):95-98. February 1971.

Key Words: nitrates, nitrites, drinking and recreational
water, epidemiology.

Abstract:

This paper discusses methemoglobin, a nitrate disease in infants; particulars of the disease; how it develops and at what levels of nitrates.

Wixson, B.G., A. Aleti, N.L. Gale, J.G. Jennett, and J.D. Morgan.

An Interdisciplinary Investigation of Environmental Pollution by Lead and Other Heavy Metals from Industrial Development in the New Lead Belt of Southeastern Missouri.

University of Missouri, Rolla, June 1972. 213p. (Available from National Technical Information Service (NTIS) as PB-227 460).

Abstract:

The primary objective was to develop a comprehensive interdisciplinary team with the capability of studying the impact of trace metals on a unique field ecosystem. This formerly undisturbed ecosystem had recently become stressed by the introduction of heavy metals caused by the relatively recent advent to lead mining, milling, and smelting operations in the area. A second objective was the conception of a research proposal to explore the techniques and collect the data required to develop an applied environmental model which could be used to predict the effects of lead and other trace metals on the ecosystem. This information could then become a model study to develop a national program of ecological protection from environmental pollution by lead and other heavy metals.

Wolf, H.W.

Biological Aspects of Water.

JAWWA. 63(3):181-188. March 1971.

Key Words: coliforms, hepatitis virus, coxsackie virus, Adeno virus, polio virus, surface water (fresh).

Abstract:

In the first article, Biological Problems with Reused Water, the author explains that there are four types of organisms that can pollute reused water: bacteria, viruses, algae, and parasitic protozoa. He describes what the dangers are from each, what methods are available for detecting the pathogens, and what can be done to rid the system of them, if such action is necessary.

Wolf, H.W., R.S. Safferman, A.R. Mixson, and C.E. Stringer.

Virus Inactivation during Tertiary Treatment.

JAWWA. 66(9):526-553. September 1974.

Key Words: viruses, polio virus, BOD, COD, ammonia, nitrates, nitrites, suspended solids, phosphates, chemical treatment, activated sludge, influent characteristics, effluent characteristics.

Abstract:

The large-scale pilot studies conducted herein demonstrated that virus removals from secondary effluents by alum coagulation-sedimentation and coagulation-sedimentation-filtration processes are essentially the same as described in the literature using smaller-scale processes. Removals of bacterial virus as high as 99.845 percent for coagulation-sedimentation and 99.985 percent for coagulation-sedimentation-filtration processes were observed at an Al:P ratio of 7:1.

At a lower alum dose there was a marked decrease in virus removals. At an Al:P ratio of 0.44:1, removals of only 46 percent of f_2 coliphage and 63 percent of poliovirus by the coagulation-sedimentation process per se were observed.

High lime treatment of secondary effluents achieved very high degrees of virus removal, but the percentage has not yet been quantified. No viable poliovirus Type 1 particles were recoverable from sludge samples taken at the optimum viral dosage times. Since viruses added in these tests were probably not imbedded in particulates that could protect them from the adverse high pH environment, these results must be interpreted with caution.

Wolf, H.W., R.S. Safferman, A.R. Mixson, and C.E Stringer.

Virus Inactivation during Tertiary Treatment.

In: Virus Survival in Water and Wastewater Systems. J.F. Malina, Jr. and B. P. Sagik, eds. University of Texas at Austin, Center for Research in Water Resources, 1974. pp. 145-157.

Key Words: virus, chemical treatment.

Abstract:

The rather large-scale pilot studies conducted herein demonstrated that virus removals from secondary effluents by alum coagulation-sedimentation and coagulation-sedimentation-filtration processes are essentially as described in the literature using smaller scale processes. Removals of bacterial virus as high as 99.845 percent for coagulation-sedimentation and 99.985 percent for coagulation-sedimentation-filtration processes were observed at an Al:P ratio of 7:1.

At a lower alum dose, a marked decrease in virus removals occurred. At an Al:P ratio of 0.44:1, removals of only 46 percent of f_2 coliphage and 63 percent of poliovirus by the coagulation-sedimentation process per se were observed.

High-lime treatment of secondary effluents achieved very high degrees of virus removal, the percentage not yet quantifiable. No viable poliovirus 1 particles were recoverable from sludge samples taken at the optimum viral dosage times. Since viruses added in these tests were not likely imbedded in particulates that could protect them from the adverse high-pH environment, these results must be interpreted with caution.

Wolverton, B.C.

Aquatic Plants for Removal of Mevinphos from the Aquatic Environment.

N.A.S.A. National Space Technology Laboratories, Bay Saint Louis, Mississippi, February 1975. 8p. (Available from National Technical Information Service (NTIS) as N75-16206).

Key Words: organophosporous pesticides, surface water (fresh).

Abstract:

Fragrant waterlily (Nymphaea odorata, Ait.), joint-grass (Paspalum distichum L.), and rush (Juncus repens, Michx.) were used to evaluate the effectiveness of vascular aquatic plants in removing the insecticide mevinphos (dimethyl-1-carbomethoxy-1 propen-2-yl phosphate) from waters contaminated with this chemical. The emersed aquatic plants fragrant waterlily and joint-grass removed 87 and 93 ppm of mevinphos from water test systems in less than 2 weeks without apparent damage to the plants; whereas rush, a submersed plant, removed less insecticide than the water-soil controls. Water-soil control still contained toxic levels of this insecticide, as demonstrated by fish bioassay studies, after 35 days.

Wolverton, B.C.

Water Hyacinths for Removal of Cadmium and Nickel from Polluted Waters.

N.A.S.A. National Space Technology Laboratories, Bay Saint Louis, Mississippi, February 1975. 11p. (Available from National Technical Information Service (NTIS) as N75-16129).

Key Words: cadmium, nickel.

Abstract:

Removal of cadmium and nickel from static water systems utilizing water hyacinths (*Eichhornia crassipes (Mart.) Solms*) was investigated. This aquatic plant demonstrated the ability to rapidly remove heavy metals from aqueous systems by root absorption and concentration. Water hyacinths demonstrated the ability to absorb and concentrate up to 0.67 mg of cadmium and 0.50 mg of nickel per gram of dry plant material when exposed for a 24-hour period to waters polluted with from 0.578 to 2.00 ppm of these toxic metals. It is found that one hectare of water hyacinths has the potential of removing 300 g of cadmium or nickel from 240,000 liters of water polluted with these metals during a 24-hour period.

Wolverton, B.C.

Water Hyacinths for Removal of Phenols from Polluted Waters.

N.A.S.A. National Space Technology Laboratories, Bay Saint Louis, Mississippi, February 1975. 18p. (Available from National Technical Information Service (NTIS) as N75-16128).

Key Words: synthetic/organics.

Abstract:

Removal of phenol by water hyacinths (*Eichhornia crassipes (Mart.) Solms*) in static water was investigated. 2.75 g dry weight of this aquatic plant demonstrated the ability to absorb 100 mg of phenol per plant per 72 hours from distilled water, river water, and bayou water. One hectare of water hyacinth plants is shown to be potentially capable of removing 160 kg of phenol per 72 hours from waters polluted with this chemical.

Won, W.D. and H. Ross.

Persistence of Virus and Bacteria in Seawater.

Journal of the Environmental Engineering Division, ASCE. 99(EE3): 205-211. June 1973.

Key Words: ECHO virus, *Escherichia coli*, surface water (marine).

Abstract:

Survival of *Escherichia coli* and Echo 6 virus was studied in aerated seawater (shaking) under ambient conditions at 38°F-40°F (3°C-5°C) and 72°F (22°C). The addition of low concentrations of organic substances, including feces, enhanced bacterial survival at 38°F-40°F. At 72°F these organics became growth-promoting for *E. coli*, sustaining a 40-fold population increase, enabling viability to persist for 18 weeks. On the other hand, the addition of organic substances did not enhance viral survival. The initial inactivation rate for this virus was greater at 72°F than at 39°F-40°F.

Wood, D.K. and G.Tchobanoglous.

Trace Elements in Biological Waste Treatment.

JWPCF. 47(7):1933-1945. July 1975.

Key Words: cobalt, copper, iron, manganese, molybdenum, zinc, activated sludge, influent characteristics, effluent characteristics.

Abstract:

Not all activated sludge operational problems are a result of trace element deficiencies. In light of the importance of trace elements for growth, the variability of their sources, and the removal mechanisms that may be operative in a wastewater system, trace element deficiencies should always be considered a possible cause for the growth of filamentous organisms that often occur in biological treatment processes.

When new treatment systems are to be built, special attention should be given to the design of trunk sewers. Adequate characterization of the waste will ensure that the proper process is selected or that appropriate modifications are incorporated in the design to treat the waste effectively.

Wood, G.W., D.W. Simpson, and R.L. Dressler.

Deer and Rabbit Response to the Spray Irrigation of Chlorinated Sewage Effluent on Wild Land.

In: Conference on Recycling Treated Municipal Wastewater through Forest and Cropland. W.E. Sopper and L.T. Kardos, eds. EPA-660/2-74-003. Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp. 286-298.

Key Words: phosphates, land reclamation.

Abstract:

The spray irrigation of chlorinated sewage effluent at the rate of two inches per week appears to have a favorable influence on the nutritive value of rabbit and deer forages. Generally, the crude protein, P, K, and Mg can be expected to be raised in these forages while the Ca is lowered. Reed canarygrass, the only forage tested for changes in digestibility due to treatment, showed no significant response with respect to digestible dry matter and protein.

Studies using the lead deer technique to determine preference for or avoidance of irrigated sites and forage from these sites indicate that the deer use treated sites at least as readily as untreated sites. During the winter period wild deer do not avoid the area but appear to use it quite readily for resting and feeding.

Woodbridge, D.D. and W.R. Garrett.

Relationship between Bacteria, Nutrients, and Rainfall in Selected Bodies of Fresh Water.

Bulletin of Environmental Contamination and Toxicology.
4:311-316. May 1969.

Key Words: coliforms, surface water (fresh).

Abstract:

Results of the study indicate that the relationship between dissolved nutrients such as phosphate and nitrate and the indicator bacteria (total coliform) are not simple or direct. Under particular conditions in specific bodies of water a direct relationship may be shown. However, the variability in the data with time and in different bodies of water raises doubts as to the direct relationship between chemical and bacterial pollutants.

Woods, C. and K.W. Brown.

Fate of Metals Applied in Sewage to Land Wastewater Disposal Sites.

USACRREL Workshop Wastewater Management via Land Treatment, Hanover, New Hampshire, 1973. 10p.

Key Words: copper, zinc, nickel, lead, ponding/land application.

Abstract:

This paper describes the goals and procedures of a study which is planned to determine the fate of Cu, Zn, Ni, and Pb when applied in sewage to land wastewater disposal sites.

Woodward, W.W., N. Hirschhorn, R.B. Sack, R.A. Cash, I. Brownlee, G.H. Chickadonz, L.K. Evans, R.H. Shepard, and R.C. Woodward.

Acute Diarrhea on an Apache Indian Reservation.

American Journal of Epidemiology. 99:281. 1974.

Key Words: epidemiology, Escherichia coli, Vibrio cholerae.

Abstract:

Diarrhea continues to be a problem for the Apache child and family due to varying conditions. E. coli, S. flexneri, and Vibrio cholerae are considered.

Worrell, C.L.

Management of Organophosphate Intoxication.

Southern Medical Journal. 68(3):335-339. March 1975.

Key Word: epidemiology.

Abstract:

This review attempts to reiterate the problem of organophosphate intoxication and the pathophysiologic problems created by these compounds. A discussion of management is included. The case reported of a two-year-old child serves to illustrate the tremendously high doses of atropine which may be required to block the acetylcholine accumulated at cholinergic synapses as a result of phosphorylation of acetylcholinesterase by organophosphorus compounds.

York, D.W. and W. A. Drewry.

Virus Removal by Chemical Coagulation.

JAWWA. 66:711-716. December 1974

Key Words: adeno virus, coxsackie virus,
ECHO virus, hepatitis virus, polio virus,
chemical treatment.

Abstract:

This paper discusses virus removal by physical chemical methods. Most coagulants gave removal efficiencies of 99% or better.

Yost, K.J., W. Bruns, J.E. Christian, F.M. Clikeman, and R.B. Jacobs.

The Environmental Flow of Cadmium and Other Trace Metals. Vol. I.

Purdue University, Lafayette, Indiana, June 30, 1973. 440p. (Available from National Technical Information Service (NTIS) as PB-229 478).

Key Words: lead, cadmium, zinc, surface water (fresh), agriculture.

Abstract:

The project is composed of two basic components: a) collaborative research with industrial and waste processing facilities whose process streams contain significant amounts of cadmium, zinc, lead and other heavy metals, and b) environmental studies to identify translocation mechanisms, distribution and fate of cadmium, lead and zinc in the urbanized, heavily industrialized Chicago-East Chicago-Gary area bordering the southern rim of Lake Michigan.

The objectives for the first year of the present study with respect to (a) were to identify, enlist the cooperation of, and initiate sampling programs in pertinent industrial and waste processing facilities. Objectives for component (b) were to scope metal contamination in the Chicago-East Chicago-Gary study area and to choose specific ecosystems and metal transport mechanisms for subsequent, more intensive study.

Yost, K.J., W. Bruns, J.E. Christian, F.M. Clikeman, and R.B. Jacobs.

The Environmental Flow of Cadmium and Other Trace Metals. Vol. II.

Purdue University, Lafayette, Indiana, June 1973. 189p. (Available from National Technical Information Service (NTIS) as PB-229 479).

Key Words: cadmium, combined municipal/industrial systems.

Abstract:

The project was composed of two basic components; a) collaborative research with industrial and waste processing facilities whose process streams contain significant amounts of cadmium, zinc, lead and other heavy metals, and b) environmental studies to identify translocation mechanisms, distribution and fate of cadmium, lead and zinc in the urbanized, heavily industrialized Chicago-East Chicago-Gary area bordering the southern rim of Lake Michigan.

The objectives for the first year of the present study with respect to (a) were to identify, enlist the cooperation of, and initiate sampling programs in pertinent industrial and waste processing facilities. Objectives for component (b) were to scope metal contamination in the Chicago-East Chicago-Gary study area and to choose specific ecosystems and metal transport mechanisms for subsequent, more intensive study. Volume II contains the last 5 of 10 chapters.

Young, D.R.

Arsenic, Antimony, and Selenium in Outfall Sediments.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1974. pp. 133-134.

Key Words: arsenic, antimony, selenium, surface water (marine).

Abstract:

The author measured values of metals in out-fall sediments. Results indicate that concentrations of arsenic and antimony remain relatively high, even at some distance from the outfalls: at 12 km, arsenic concentrations were still one-fourth the values at the station closest to the outfalls, and antimony values were still one-half the outfall values.

Young, D.R.

Cadmium and Mercury in the Southern California Bight.

Southern California Coastal Water Research Project.
El Segundo, Ca., October 1974. 16p.

Key Words: cadmium, mercury, suspended solids, surface water (marine), effluent characteristics.

Abstract:

This report summarizes the Southern California Coastal Water Research Project's findings on the trace metals cadmium and mercury in the Southern California Bight.

Young, D.R.

Mercury Concentrations in D ated Varved Marine Sediments Collected off Southern California.

Nature. 244(5415):273-275. August 3, 1974.

Key Words: mercury, surfac e water (marine).

Abstract:

It appears that, durin approximately the past 100-150
years, human activitie have resulted in a rather similar
pattern of increased m ercury introduction to several
reservoirs in the nort hern hemisphere. The Santa Barbara
Basin dated varved sed iments show higher concentrations
beginning about the tu rn of the century, suggesting that
increased regional inp uts of mercury to the southern
California coastal wat ers occurred about the same time as
in several other regio ns of economic growth in the
northern hemisphere. According to this interpretation,
the anthropogenic inpu t rate of mercury to this coastal
marine reservoir seems roughly to have matched the natural
input rate in recent y ears.

Young, D.R. and T. Jan.

Chromium in Municipal Wastewater and Seawater.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1975. pp. 147-149.

Key Words: chromium, surface water (marine), influent characteristics.

Abstract:

The authors observed that 90% of the dissolved chromium in Hyperion effluent occurred in the trivalent form; the levels found were 52 and 61 ppb, travalent and trivalent-hexavalent, respectively.

Young, D.R. and T.C. Heesen.

Contaminants in Harbors.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1974. pp. 105-108.

Key Words: DDT, chlorinated hydrocarbons, effluent characteristics, shellfish.

Abstract:

Data here indicate that DDT and PCB levels in municipal wastewater discharges are minimal when compared to the input from surface runoff.

Young, D.R. and D.J. McDermott.

DDT in Benthic Fishes.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1974. pp. 113-115.

Key Words: DDT, fish.

Abstract:

The major source of contamination of Dover sole trawled between Redondo Canyon and the western entrance of Los Angeles Harbor is the waste material generated during the manufacture of DDT and subsequently discharged to the marine environment via the Palos Verdes submarine outfalls.

Although the release of these wastes to the sewage collection system of the County Sanitation Districts of Los Angeles County was discontinued and the marine inputs of DDT via these outfalls decreased considerably, a substantial percentage of the fish closely associated with the benthic food web on the Palos Verdes Shelf two years later still contained excessive concentrations of DDT in their flesh. The enrichment of DDT concentrations in the resident fish may well be due to the large reservoir of total DDT in the upper 12 cm of bottom sediments on the Palos Verdes Shelf, much of this material near enough to the sediment surface to be available to the benthic food web. Thus, it is possible that these contaminated sediments are an important (perhaps now the dominant) local source of DDT compounds to the ecosystem of the shelf.

Young, D.R. and I.S. Szpila.

Decreases of DDT and PCB in Mussels.

Southern California Coastal Water Research Project.
Annual Report. El Segundo, Ca., June 30, 1975. pp. 123-126.

Key Works: DDT, chlorinated hydrocarbons, shellfish.

Abstract:
Intertidal mussel appears to have accurately reflected decreases in the input of DDT and PCB's to the total ecosystem. The study also indicates that local annual inputs and biological concentrations of PCB are decreasing less rapidly than those for DDT.

Young, D.R. and T.C. Heesen.

Inputs and Distributions of Chlorinated Hydrocarbons in Three Southern California Harbors.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 1974. pp. 101-104.

Key Words: DDT, chlorinated hydrocarbons, surface water (marine), shellfish, surface water (fresh).

Abstract:

Chlorinated hydrocarbons such as the pesticide DDT and industrial polychlorinated biphenyls (PCB) are major contaminants in southern California marine waters. As a result of a predominant DDT input from the large submarine discharge of Los Angeles County municipal wastewater, coastal mussels off Los Angeles contain up to 30 times more p,p'-DDE than do those off San Diego. Specimens of a bay mussel collected from San Diego Bay, Newport Harbor, and San Pedro Harbor also show this pattern of increasing DDT concentrations toward Los Angeles. However, PCB 1254 concentrations are similar in mussels from the three harbors and are several times higher than in specimens collected from the nearby coastal waters. Estimates for total annual inputs of PCB 1254 to these harbors from municipal wastewater, industrial wastewater, surface runoff, aerial fallout, and vessel antifouling paints range from 1 kg/yr in Newport Bay to 150 kg/yr in San Pedro Harbor, with surface runoff and industrial wastewater constituting virtually all of the latter input. Although antifouling paints presently constitute a completely insignificant mode for PCB input to these harbors, occasional high PCB concentrations in old paint chips and the correlation of mussel PCB concentrations with antifouling paint usage suggest that this may have been the predominant source of PCB to southern California harbors in recent years. It is not yet known how long these harbors will exhibit PCB contamination levels higher than those of the adjacent coastal waters.

Young, D.R. and T.C. Heesen.

Inputs of Chlorinated Benzenes.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1976. pp. 31-38.

Key Words: aromatic acids, surface water (marine).

Abstract:

This article is a discussion of the types and quantities of various chlorobenzene compounds in municipal effluent, surface runoff, and aerial fallout. It concludes that effluent is the major source of contamination, but gives no concentrations in coastal waters. There is a brief discussion of uses and toxicities.

Young, D.R. and T.C. Heesen.

Inputs of Chlorinated Hydrocarbons.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1974. pp. 97-99.

Key Words: DDT, dieldrin, chlorinated hydrocarbons, surface water (marine).

Abstract:

Discharges of DDT wastes from the Palos Verdes submarine outfalls have resulted in unusually high levels of this pesticide in our coastal waters. In addition, polychlorinated biphenyls (PCB) released from several large municipal systems have caused local enhancements of this industrial material near the points of discharge.

Because of the importance of these synthetic organics, we need to relate their input rates via municipal wastewaters to those from other sources. The authors conducted a survey (about 80 percent completed) of chlorinated hydrocarbon inputs to our coastal waters from six possible routes: municipal wastewater, direct industrial discharge, surface runoff, antifouling points, aerial fallout, and ocean currents.

Young, D.R. and T.C. Heesen.

Inputs of DDT and PCB.

Southern California Coastal Water Research Project.
Annual Report. El Segundo, Ca., June 30, 1975. pp. 105-109.

Key Words:
DDT, chlorinated hydrocarbons, surface water (marine).

Abstract:

The survey of approximately 40 industrial effluents being discharged directly into San Pedro and San Diego Harbors has produced no evidence that such discharges presently constitute a significant source of chlorinated hydrocarbons to the local marine waters.

It appears that inputs of PCB compounds to the Southern California Bight from the adjacent coastal plain are several times larger than those of DDT compounds. In contrast to DDT, the major PCB inputs are broadly distributed along the coast; thus, it may be considerably more difficult to obtain significant reductions in the quantities of PCB reaching the local marine ecosystem.

Young, D.R. and T.C. Heesen.

Inputs of DDT and PCB.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 1976. pp. 23-30.

Key Words: DDT, dieldrin, chlorinated hydrocarbons, surface water (marine).

Abstract:

In the past, submarine discharge of municipal wastewater has been the dominant source of chlorinated hydrocarbons such as DDT, Dieldrin, and 1242 and 1254 PCB to the Southern California Bight. Dieldrin inputs have been of only second-order importance compared to those of DDT, and other chlorinated pesticide inputs have been insignificant. PCB contamination of these wastewaters is ubiquitous; in contrast, DDT inputs have been completely dominated by industrial wastes released by a single pesticide manufacture to Los Angeles County's sewer system.

Control of this input to JWPCP in 1970 has reduced the submarine introduction of DDT-contaminated particulates by more than 95 percent since 1971. PCB emissions (mostly 1242) via submarine outfalls have decreased by an order of magnitude since 1972, possibly as a result of the 1971 restriction of PCB usage to closed systems.

Neither direct industrial discharges nor antifouling paints now appear to be significant sources of chlorinated hydrocarbons to the Bight. However, past use of PCB in the paints may have constituted a major input to the marine ecosystem, which the 1971 restriction apparently has now controlled.

Surface runoff has made only second-order contributions of chlorinated hydrocarbons to the Bight, almost all from storm flow. The Los Angeles Basin has been the major source region, constituting approximately 85 to 95 percent of the individual inputs of total DDT, Dieldrin, and total PCB via runoff.

Since 1974, dry aerial fallout has been the dominant route by which total DDT is transferred from southern California to the coastal ecosystem; for 1254 PCB, this situation may have existed even earlier. However, 1242 PCB, a relatively volatile mixture, appears to have occurred at lower levels than 1254 PCB in aerial fallout and recent surface runoff. During 1975, the greatest inputs of 1242 PCB were still being carried via municipal wastewater discharge.

The manufacture of DDT in Los Angeles County, and losses from past landfill deposits of resultant wastes, may be contributing significantly to coastal inputs of this contaminant via aerial fallout. In contrast, PCB inputs to the atmosphere appear to be much more diffuse. Fallout rates of both contaminants in this region are slowly decreasing.

Young, D.R. and T. Jan.

Metals in Scallops.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1976. pp. 117-122.

Key Words: cadmium, chromium, molybdenum, lead, nickel, zinc, shellfish.

Abstract:

This was a study of analyses of tissue samples from rock scallops collected near a Los Angeles County wastewater outfall (Palos Verdes). Although the scallops appeared to concentrate all of these metals to one degree or another, no conclusions were drawn other than to point out the existence of a potential problem.

Young, D.R. and T.R. Folsom.

Mussels and Barnacles as Indicators of the Variation of Manganese-54, Cobalt-60, and Zinc-65 in the Marine Environment.

Presented at the IAEA Symposium on the Interaction of Radioactive Contaminants with the Constituents of the Marine Environment, Seattle, Washington, July 10-14, 1972. 17p.

Key Words: manganese, cobalt, zinc, surface water (marine), surface water (fresh), shellfish.

Abstract:

The intertidal byssal mussel *Mytilus californianus* and the oceanic gooseneck barnacle *Lepas anatifera* are efficient indicators of spatial and temporal changes in levels of three radiometals (manganese-54, cobalt-60, and zinc-65) in the marine environment.

Young, D.R. and D. McDermott-Ehrlich.

Sediments as Sources of DDT and PCB.

Southern California Coastal Water Research Project.
Annual Report. El Segundo, Ca., June 30, 1976. pp. 49-56.

Key Words: DDT, chlorinated hydrocarbons, surface water (marine), fish.

Abstract:

These findings indicate that contamination of bottom sediments by chlorinated hydrocarbons such as DDT and PCB can cause these synthetic compounds to persist in bottom-feeding fishes long after major reductions have been made in the dominant inputs. This conclusion is consistent with that of a laboratory study performed at the SCCWRP, which showed that Dover sole maintained in clean, flowing seawater and fed clean food nevertheless accumulated high levels of DDT and PCB when exposed to outfall zone sediments contaminated with these compounds.

It therefore appears that the relatively high levels of DDT now found in bottom-feeding fishes around the JWPCP submarine outfalls will decrease only as rapidly as do corresponding levels in the bottom sediments of this region. Based on studies reported in this and past reports, we estimate that approximately 150 tons of total DDT are still contained in the upper 30 cm of these sediments in a 50-sq-km area off Palos Verdes Peninsula. Thus, despite the recent major reductions in JWPCP inputs, these highly contaminated sediments may cause excessive DDT levels to persist for many years in benthic fishes of the region.

Young, D.R. and D.J. McDermott.

Trace Metals in Harbor Mussels.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1975. pp. 139-142.

Key Words: copper, chromium, lead, zinc, shellfish.

Abstract:

This article reports findings from limited survey of the bay mussel (Mytilus edulis) from three major harbors -- San Pedro, Newport, and San Diego. Of the four potentially toxic trace metals considered in this study (copper, chromium, nickel and zinc), copper values were most anomalous: both San Diego and Newport harbor specimens had significantly higher tissue levels of this metal than did the coastal controls. The submarine discharges of municipal wastewater off San Diego and Newport Beach do not appear to have caused increased levels of these metals in the coastal specimens.

Young, D.R. and T. Jan.

Trace Metals in Nearshore Seawater.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Ca., June 30, 1975. pp. 143-156.

Key Words: cadmium, chromium, copper, nickel, suspended solids, ammonia, surface water (marine).

Abstract:

The results of the research indicate that, although very large increases in particulate concentrations of metals can occur in the wastewater plume near a major municipal outfall, there are much smaller increases in the dissolved fraction. The largest such concentration measured in the plume was about 1 μg/l for nickel, which is probably the most soluble of any of the trace metals now regulated. Furthermore, although the increases in plume concentrations above control values for dissolved copper and nickel were statistically significant, these levels were less than those measured at the mouths of three major harbors. Chromium and cadmium showed only slight increases in the dissolved fraction of the plume; these increases, which did not exceed a factor of 2, were not significant. Chromium levels ranged from 0.2 to 0.5 μg/l; these values are within the range of reported seawater concentrations and also within the range observed in our harbor mouth study.

Thus, as plume dilutions increase several times beyond the factors of 100 to 350 that we found within 2 km of the JWPCP submarine outfalls, levels of dissolved metals from the effluent probably will become indistinguishable from baseline values for the adjacent nearshore waters.

Young, D.R., D.J.McDermott, T.C. Heesen, and D.A. Hotchkiss.

DDT Persists in Southern California Ocean Sediments and Organisms Long After Industrial Source Stops.

Bulletin (California Water Pollution Control Association) 12:62-66. July 1975.

Key Words: DDT, surface water (marine).

Abstract:

The major source of this contamination was the industrial-waste material generated during the manufacture of this pesticide and subsequently discharged to the marine environment by the County Sanitation Districts of Los Angeles County (SDLAC) via the Joint Water Pollution Control Plant (JWPCP) submarine outfalls off Whites Point, Palos Verdes Peninsula. Data indicates that DDT levels are persisting in sediments off Southern California.

Young, D.R., D.J. McDermott, T.C. Heesen, and T.K. Jan.

Pollution Inputs and Distributions Off Southern California.

ACS Symposium Series. 18:424-439. 1975.

Key Words: copper, mercury, DDT, chlorinated hydrocarbons, surface water (marine), surface water (fresh).

Abstract:

Municipal wastewaters are the dominant known source of numerous trace contaminants to the Southern California Bight. Annual inputs of mercury, DDT, and PCB via this route are an order of magnitude larger than those from direct industrial discharges and storm runoff. Aerial fallout is also a major source of chlorinated hydrocarbons. Bottom sediments around the largest outfall system are highly contaminated by various trace elements and DDT residues. Corresponding contamination of benthic organisms occurs for DDT but not the trace elements studied. Seawater collected from the mouths of three important harbors contained copper and the chlorinated hydrocarbons at the part-per-billion and part-per-trillion level, respectively.

Young, D.R., C.S. Young, and G.E. Hlavka.

Sources of Trace Metals from Highly Urbanized Southern California to the Adjacent Marine Ecosystem.

In: Cycling and Control of Metals. M.B. Curry and G.M. Gigliotti, ed. National Environment Research Center, Cincinnati, Ohio, February 1973. pp. 21-39.

Key Words: copper, mercury, zinc, lead, cobalt, iron, manganese, cadmium, chromium, nickel, surface water (marine), surface water (fresh), effluent characteristics.

Abstract:
This paper discusses trace metal emissions to the Southern California Bight from municipal wastewater, surface runoff, rainfall, vessel coating and ocean dumping. It is difficult to draw any very reliable conclusions from the comparison of local versus advective inputs until more is known about the net addition of metals to, or removal from, the Bight due to bottom sediment interactions and to ocean circulation.

Young, G.E. and G.A. Carlson.

Economic Analysis of Land Treatment of Municipal Wastewaters.

North Carolina Water Resources Research Institute, Raleigh, October 1974. 113p. (Available from National Technical Information Service (NTIS) as PB-239 186).

Key Words: BOD, ponding/land application.

Abstract:

The 1972 Water Pollution Control Act Amendments require increased treatment of municipal wastewaters. One method to obtain a high quality effluent at relatively low cost compared to other techniques is land treatment. This study compares and evaluates conventional in-plant treatment and land treatment in a cost framework and in a production efficiency framework. The major objective is to explain why more municipalities have not chosen land treatment in the past. Regression analysis was used to estimate cost functions for 125 municipal treatment plants across the southern portion of the United States. Comparison of the two types indicates that inclusion of land treatment permits higher levels of treatment per dollar of expenditure. The advantages of land treatment are greater for small plants. A .5 million gallons per day (mgd) plant will save $.07 per 1000 gallons treated to 85 percent removal of five-day biochemical oxygen demand (BOD_5) if it uses land treatment, while a 10 mgd plant will save $.05 per 1000 gallons. Cost differentials are greater for treatment to 95 percent removal.

Young, J.C., R.E. Baumann, and D.J. Wall.

Packed-Bed Reactors for Secondary Effluent BOD and Ammonia Removal.

JWPCF. 47(1):46-56. January 1975.

Key Words: BOD, suspended solids, ammonia filtration, nitrification/denitrification, trickling filter.

Abstract:

The PBR and dual-media filter systems have been shown to provide a high degree of polishing for low-quality secondary effluents. Effluent BOD was reduced consistently to below 10 mg/l (90 percent of samples), and SS concentrations were reduced to below 5 mg/l. Nitrification was accomplished throughout a complete winter operation period, and effluent ammonia nitrogen concentrations averaged less than 1 mg/l.

Three PBR media -- sand, crushed coal, and loosely-packed plastic -- gave about the same BOD and SS removal performance. Therefore, the selection of media seems to be related more to design and operational simplicity and cost rather than to media size and shape. Studies by McHarness and McCarty and Seidel and Crites showed similar results for large granular media such as rock or volcanic cinders in PBR systems used for biological denitrification. In systems for which the rate of air or gas flow through the unit was "small", plugging was a problem. However, no plugging problems were experienced in more than 10 months of continuous operation with the coal- and plastic-media PBR units used for nitrification and in 4 months of operation of the sand-medium PBR.

The series PBR system described in this paper provided nitrification of trickling filter effluent when operated at an influent flow rate of 0.5 gpm/sq ft (20 l/min/sq m) without any chemical feed for pH control. At an influent ammonia concentration of 15 mg/l, this represented an ammonia loading of 6.9 lb NH_3-N/day/1,000 cu ft (0.11 kg/day/cu m) of media volume at a detention time of 3.25 hr on an empty-tank basis. These loading and detention times represent an improvement over that indicated previously for activated sludge systems operating at 10°C, particularly when it is recognized that no pH adjustment was made in the PBR system.

The operation of PBR's is relatively simple compared with the operation of activated sludge systems. Hydraulic surges do not cause an extreme loss of nitrifying organisms from the PBR system. This is a notable problem with activated sludge systems, which are difficult to restart at cold wastewater temperatures if appreciable quantities of mixed liquor solids are lost because of hydraulic surges or poor sludge settling characteristics.

Although comprehensive design criteria have not been developed for PBR systems used for nitrification, the studies and results reported in this paper do provide guidelines for the design of full-scale plants with a reasonable assurance of providing satisfactory treatment. To improve performance over that indicated in the studies reported, provision should be made for recirculating solids removed on the filters back to the PBR units and to add chemicals for pH control.

Pilot-plant studies are continuing to determine in more detail design criteria for PBR-filter systems for biological nitrification and for polishing effluents for additional BOD and SS removal.

Young, R.A., P.N. Cheremisinoff, and S.M. Feller.

Tertiary Treatment: Advanced Wastewater Techniques.

Pollution Engineering. 7(4):26-33. April 1975.

Key Words: BOD, suspended solids, phosphates, COD, total dissolved solids, ammonia, gravity separators, chemical treatment, adsorption/ion exchange, nitrification/denitrification.

Abstract:

This article is a general discussion of sedimentation, chemical precipitation, activated carbon adsorption, ion exchange, ammonia stripping, chlorination, and ozonation.

Young, R.H.F. and N.C. Burbank, Jr.

Virus Removal in Hawaiian Soils.

JAWWA. 65:598-604. September 1973.

Key Words: viruses, groundwater.

Abstract:

Significant differences were observed between the bacteriophage studies and the work on animal viruses. Results obtained with bacteriophage showed that 2 1/2- and 6-in. soil columns of Wahiawa and Lahaina soil removed 100 percent of the applied coliphage T_4 at a feed concentration of 1.5×10^6 pfu/ml. Several properties possessed by soils may serve as possible removal mechanisms of bacteriophage T_4, namely, the effects of surface straining (or clogging), cation exchange, and physical adsorption. Since the size of phage particles leaves them relatively unaffected by surface training, and since the Wahiawa and Lahaina soils are classified low humic latosols with low cation-exchange capacity compared to other Hawaiian soils, physical adsorption was probably the effective mechanism in the phage removal by these soils.

The poliovirus experiment showed that even the 6-in. columns of Wahiawa and Lahaina soils were unable to effect 100 percent retention of poliovirus Type II with an initial feed concentration of 1.5×10^5 pfu/ml. The removal obtained with Tantalus cinder was even less. Therefore, if bacteriophage is used as a model in percolation studies similar to that conducted for animal viruses, the limitations and basic differences must be recognized and evaluated.

Adsorption of viruses by soils is influenced by many factors. Physical adsorption of viruses is only slightly affected by temperature variations, but pH plays a major role. Although viruses exist in other forms, the only unit of viral structure that has been isolated and subjected to direct examination is virion. Since virions are composed of either deoxyribonucleic acid (DNA) or rubonucleic acid (RNA), they possess the amphoteric property of proteins. Therefore, as the pH decreases, there is also a decrease in the ionization of the hydroxyl groups and the virions behave like anions. Soil is known to have a negative charge, hence adsorption takes place.

Youngner, V.B. and T.E. Williams.

Ecological and Physiological Implications of Greenbelt Irrigation. Progress Report of the Maloney Canyon Project - 1973.

University of California at Riverside. Department of Plant Sciences, 1973. 106p. (Available from National Technical Information Service (NTIS) as PB-231 376).

Key Words: nitrates, phosphates, air, direct contact, ponding/land application.

Abstract:

The project was designed to examine the feasibility of an effluent-irrigated chaparral ecosystem as a greenbelt fuel-break for fire prevention, and to serve as a renovation system for wastewater recycling. An expanded water monitoring program encompassing analyses of surface and ground waters was implemented as an indicator of areas of wastewater contaminant accumulation. Soils and plants were analyzed for nutrient removal characteristics and patterns of native and introduced vegetation survival and growth were correlated into a feasible design for an effective greenbelt vegetation system. Results appear to be favorable to the project objectives of wastewater renovation and fire suppression through greenbelt establishment.

Yu, C.C. and J.R. Sanborn.

The Fate of Parathion in a Model Ecosystem.

Bulletin of Environmental Contamination and Toxicology.
13:543-550. May 1975.

Key Words: organophosphorus pesticides, surface water (fresh), fish.

Abstract:

In this article the fate of parathion through a laboratory system is traced; data presented show that parathion does not accumulate to any appreciable extent in any of the organisms studied.

Yu, C.C., D.J. Hansen, and G.M. Booth.

Fate of Dicamba in a Model Ecosystem.

Bulletin of Environmental Contamination and Toxicology. 13:280-283. March 1975.

Key Words: herbicides, surface water (fresh), fish.

Abstract:

Dicamba persisted in water in conjugated or in anionic forms. It slowly transformed to 5-hydroxy dicamba in water (about 10% after 32 days) and was very slowly decarboxylated. Dicamba did not magnify in the food chain organisms.

Yu, W.C.

Selective Removal of Mixed Phosphates by Activated Alumina.

JAWWA. 58(2):239-247. February 1966.

Key Words: phosphates, chemical treatment.

Abstract:

Activated alumina selectively removes OP, PP, TPP, and HTP -- the forms of phosphate most commonly associated with stream pollution. The cheapest material tested was Type A alumina. The most efficient mode of operation is by downflow through a packed bed of solid. More than 99 percent removal is accomplished in this fashion, using tap water solutions initially containing 5 ppm and 25 ppm of each type of phosphate. These concentration levels are comparable to those in water streams and in secondary waste treatment plant effluents, respectively. In both cases, then, the process should be directly applicable, providing solids in the waste solution do not clog the packed bed of alumina.

Volume reduction factors are high enough to make the process economically attractive, because only small amounts of caustic and nitric acid are required to regenerate and reuse the cheap Type A alumina. Columnar sorption of phosphates using activated alumina does not alter the chemical composition of the treated water in the pH range tested. On the other hand, alum or iron flocculation adds salt to the treated water and lime precipitation increases the pH and calcium ion concentration. The ever increasing consumption of both phosphate-containing fertilizers and organic detergents -- the main sources of phosphate pollution of water streams -- makes this process an increasingly important one.

Zaloum, R. and K.L. Murphy.

Reduction of Oxygen Demand of Treated Wastewater by Chlorination.

JWPCF. 46(12):2770-2777. December 1974.

Key Words: BOD, chlorination.

Abstract:

The chlorination of filtered final effluents does not bring about a reduction of BOD, nor does it render the soluble organics bioresistant or toxic to micro-organisms; there was no significant difference in the extent of carbon degradation. Chlorination does not effect a reduction in the organic carbon content of filtered wastewaters, as evidenced by the unchanged values of COD and BOD. In these studies, with the exception of one run, the 5-day BOD does not seem to represent the carbonaceous demand of the filtered waste; there was negligible carbon degradation and this degradation seems to be mainly a result of microbial respiration. Because of the presence of ammonia in wastewater, chlorine in the firm of chloramines is not likely to oxidize the soluble organics presents.

The seeding procedure used for the comparison of the BOD of a chlorinated-dechlorinated and unchlorinated, unfiltered wastewater is inadequate and does not guarantee equal microbial concentrations even within the accuracy of the test. At least a uniformly mixed population will be present. The BOD reductions and the observed lag phases or delays in the exertion of the BOD that were reported by previous investigators might have been caused by this unequal microbial concentration and not by any qualitative and quantitative changes in the constituents of wastewater.

The induced toxicity of chlorine, present as chloramines, increased as the applied chlorine concentration is increased. It is characterized by longer lag phases and reduced BOD. A residual of 0.5 mg/l of chlorine, added to seeded, filtered effluent, might possibly have induced a selective kill of micro-organisms; an increase in the 5-day BOD values that cannot be attributed to the inaccuracy of the test was observed. A reduction in BOD will be observed if a residual chlorine is left in the sample or if an unequal microbial concentration is present as a result of chlorination. A lasting residual

will effect a maximum reduction. Some micro-organisms will survive chlorination, however, as evidenced by the exertion of BOD at an applied residual of 0.8 mg/l Cl, which lasted more than 45 min.

Zanitsch, R.H. and J.M. Morand.

Tertiary Treatment of Combined Wastewater With Granular Activated Carbon.

Water and Wastes Engineering. 7:58-60. September 1970.

Key Words: total organic carbon, BOD, suspended solids, adsorption/ion exchange.

Abstract:

This article describes a study to determine the feasibility of removing refractory organic material and dyes from an activated sludge effluent using granular activated carbon. A colorless effluent containing an average of 3 mg per L BOD and 3 mg per L suspended solids was produced in the 61-day trial.

Zellich, J.A.

Toxicity of Combined Chlorine Residuals to Freshwater Fish.

JWPCF. 44(2):212-220. February 1972.

Key Words: synthetic/organics, chlorination.

Abstract:

Wastewater effluents are chlorinated to destroy inherent pathogenic organisms before the effluents are discharged. The chlorine combines with a number of materials, especially ammonia, to form extremely toxic compounds.

Laboratory studies demonstrated that exceedingly small amounts of chlorine (less than that required to obtain any measurable residual chlorine) added to nontoxic effluents containing thiocyanate produces a very toxic solution. It is believed that cyanogen chloride is the toxicant formed and the threshold concentration of this compound has been reported as 0.08 mg/l for rainbow trout.

Laboratory studies have shown that chloramine concentrations of a few tenths of a milligram per liter are lethal to warmwater fish such as sunfish, bullheads, and minnows.

Chloramine concentrations of 0.06 to 0.08 mg/l are lethal to trout.

Life cycle studies have shown that chloramine concentrations of 0.085 mg/l nearly eliminate the spawning of the fathead minnow and that concentrations of 0.043 mg/l significantly reduce reproduction.

Recent on-site continuous-flow bioassays at Michigan treatment plants have shown that chlorinated effluents were toxic after diluting them to 2.0 to 4.0 percent. Furthermore, average concentrations of 0.16 to 0.21 mg/l residual chlorine caused complete kills of fathead minnows. As low as 0.07 mg/l caused a partial kill of the test fish, and 0.04 to 0.05 mg/l were the threshold concentrations of these wastes.

An extensive field survey of fish populations in four Maryland streams showed that chlorinated effluents have a twofold effect on fish. First, the effluent significantly reduces the species diversity and

total number of fish below the outfall. After the toxic effects have been eliminated and the organic matter begins to decompose, the subsequent deoxygenation of the receiving stream causes a species shift and many of the more sensitive fish may be eliminated.

The addition of thiosulfate to toxic chlorinated compounds rendered them nontoxic. This has been proven in laboratory and field conditions.

Discharges of chlorinated effluents render portions of the receiving waters toxic to fish. The extent of those waters that are unavailable to fish is dependent on thedilution and stability of the chloramines. Because the maximum safe concentration of chloramines seems to be very low, the ultimate impact of these compounds will be determined by their stability. The stability of chloramines is presently being studied by the Michigan Water Resources Commission.

Zenz, D., J. Peterson, D. Brooman, and C. L. Hing.

Digested Sludge Recycle to Strip-Mine and Farmlands - Effects on Public Health, Environmental Quality and Row Crops.

Metropolitan Sanitary District of Greater Chicago, October 1974. 47p.

Key Words: BOD, nitrates, nitrites, phosphates, suspended solids, ammonia, iron, zinc, copper, manganese, chromium, nickel, cadmium, coliforms, viruses, groundwater, crops.

Abstract:

Since 1971, the Metropolitan Sanitary District of Greater Chicago (District) has engaged in an extensive environmental monitoring program at its Fulton County land reclamation site. The monitoring program has included monitoring of all streams and other surface water on the site including all runoff water from the fields receiving digested sludge. The data indicates that digested sludge application to the Fulton County site has no adverse effect upon surface water quality. Discharges from the fields receiving digested sludge have met Illinois EPA standards for BOD, total suspended solids (TSS), and fecal coliform (FC). Analysis of stream water entering and leaving the site indicates an improvement in water quality after passage through the Fulton County Site in terms of NH_3-N, NO_2+NO_3-N, fecal coliform and virus levels.

Analysis of groundwater from 23 wells drilled on the site indicates that the migration of constituents present in digested sludge into the aquifer is not occurring. Increases in NO_2+NO_3 nitrogen and iron has not occurred in wells located in areas receiving digested sludge.

Analysis of corn grain grown with digested sludge shows no significant increase in metal levels since the Fulton County project began.

Zenz, D.R., B.T. Lynam, C.L. Hing, R.K. Rimkus, and T.D. Hinesly.

USEPA Guidelines on Sludge Utilization and Disposal - Review of Its Impact upon Municipal Wastewater Treatment Agencies.

Metropolitan Sanitary District of Greater Chicago, 1975. 72p.

Key Words: cadmium, copper, mercury, nickel, lead, zinc, chromium, iron, agriculture, crops.

Abstract:

This paper describes a research project to determine the effect of sludge application upon the heavy metal content of crops. The data indicate that, contrary to EPA proposed guidelines, heavy metal levels are not related to total sludge applications.

Zepp, R.G., N.L. Wolfe, J.A. Gordon, and G.L. Baughman.

Dynamics of 2,4-D Esters in Surface Waters; Hydrolysis, Photolysis, and Vaporization.

Environmental Science and Technology. 9(13):1144-1150. December 1975.

Key Words: synthetic/organics, surface water (fresh).

Abstract:

The chemical hydrolysis, photolysis, and volatilization of several commonly used 2,4-D esters were studied. The hydrolysis rates are strongly dependent upon ester structure; esters possessing ether linkages near the carboxyl group generally hydrolyze more rapidly than hydrocarbon chain esters. The rapid hydrolysis rates observed in basic water suggest that hydrolysis is often the major pathway for transformation of 2,4-D esters in natural waters. Photo-products of 2,4-D esters are monochlorophenoxyacetic acid esters in hydrocarbon media and in ester-water emulsions; in aqueous solution, chlorohydroxyphenoxyacetic acid esters and 2,4-dichlorophenol are formed. Direct photolysis in water is a slow process; the minimum photolysis half-life of the butoxyethyl ester under September sunlight is about 14 days in the southern United States. The photolysis rate is pH-independent, but it depends strongly upon time of day, season, and latitude. Calculations based upon solubilities and vapor pressures of 2,4-D esters indicate that volatilization may be a significant mechanism in the loss of hydrocarbon chain esters from environmental waters.

Zimansky, G.M.

Removal of Trace Metals during Conventional Water Treatment.

JAWWA. 66(10):606-609. October 1974.

Key Words: cadmium, chromium, copper, iron, lead, manganese, zinc, filtration.

Abstract:

It is apparent that the water-treatment plants studied and probably other similar plants are capable of removing iron, manganese, and zinc to a high degree as well as copper and nickel to a lesser degree. At the same time, it is evident that chromium and lead are only slightly removed and molybdenum negligibly removed. For all metals, percentage plant removals were greater when source water influent to the plant had higher metal concentrations. Frequently, if a metal was significantly removed by the clarifiers, subsequent filter-removal percentages were low. The reverse was also indicated. This was not observed often for iron, manganese, or zinc.

For the same plant sampled at different times and under varied loading conditions, percentage removals for all metals decreased as hydraulic loading rates increased. Because of other factors, there did not appear to be a reliable correlation between loading rates and percentage removals of different plants. It is felt that differences in efficiency of chemical addition, flocculation, and type of filter media were most significant.

Zimmerman, L.

Survival of Serratia marcescens after Freeze-Drying or Aerosolization at Unfavorable Humidity. I: Effects of Sugars.

Journal of Bacteriology. 84:1297-1302. 1962.

Key Words: bacteria, air.

Abstract:

Suspensions of Serratia marcescens were subjected to freeze-drying or to aerosolization at unfavorable humidity levels. The survival of the cells during one or the other of these treatments was markedly improved in the presence of common sugars, but no one sugar stabilized the cells against both stresses. The protective effects of the sugars were correlated with their penetrability into cells; minimally penetrable sugars stabilized cells against aerosolization, and freely penetrable sugars stabilized cells during freeze-drying. These results were attributed to the modifications of intracellular water content induced by the presence of the sugars in the cell suspensions.

Zitko, V.

Uptake of Chlorinated Paraffins and PCB from Suspended Solids and Food by Juvenile Atlantic Salmon.

Bulletin of Environmental Contamination and Toxicology. 12:406-412. April 1974.

Key Words: synthetic/organics, fish.

Abstract:

In contrast to PCB, chlorinated paraffins are much less accumulated, if at all, by juvenile Atlantic salmon.

Zitko, V. and W.V. Carson.

Release of Heavy Metals from Sediments by Nitrilotriacetic Acid (NTA).

Chemosphere. 1(3):113-118. May 1972.

Key Words: copper, zinc, iron, mercury, cadmium, surface water (fresh), surface water (marine).

Abstract:

Cupric, zinc and ferric ions are released from aquatic sediments by nitrilotriacetic acid (NTA). Model experiments indicate that cadmium and mercuric ions behave similarly. Concentration of NTA as low as 1.0 mg/l produces in some cases measurable release of these ions. The release of heavy-metal ions is somewhat depressed by increased water hardness. In model experiments with ion exchange resins NTA affects only ions bound to carboxyls and has no effect on ions bound to sulfo groups.

Zitko, V., B.J. Finlayson, D.J. Wildish, J.M. Anderson, and A.C. Kohler.

Methylmercury in Freshwater and Marine Fishes in New Brunswick, in the Bay of Fundy, and on the Nova Scotia Banks.

Journal of the Fisheries Research Board of Canada. 28(9):1285-2191. September 1971.

Key Words: mercury, fish.

Abstract:

American eel (*Anguilla rostrata*), chain pickerel (*Esox niger*), white perch (*Morone americana*), yellow perch (*Perca flavescens*), brook trout (*Salvelinus fontinalis*), and Atlantic salmon (*Salimo salar*) contained 0.07-2.08, 0.27-1.58, 0.75-1.07, 0.20-1.05, 0.08-0.13, and 0.09 ppm of methylmercury, expressed as mercury on wet weight basis, respectively. With only two exceptions, levels of methylmercury in marine fish were below 0.13 ppm. Some of the freshwater sampling locations could be directly associated with an industrial activity in the area, whereas others suggested pollution by airborne mercury. However, the concentration of methylmercury in eels from a lake in New Brunswick did not change over period of 46 years, indicating that elevated levels of mercury may in some instances reflect the natural situation.

ZoBell, C.E.

Carcinogenic Hydrocarbons as Marine Environmental Pollutants: A Preliminary Report.

In Sources and Biodegradation of Carcinogenic Hydrocarbons. API/EPA/USCG Conference on the Prevention and Control of Oil Spills, La Jolla, California, 1971. pp. 441-451.

Key Words: synthetic/organics, groundwater, surface water (marine), crops, food processing, fish, air, direct contact, fish, shellfish, drinking and recreational water, livestock.

Abstract:

The carcinogenicity of chemical compounds depends upon chemical structure, susceptibility of the organism to cancer, size and periodicity of dosage, mode of administration and several other factors.

Amont the most potent carcinogenic hydrocarbons are 3,4-benzpyrene, 20-methylcholanthrene, 9,10-dimethyl-1,2,5,6-dibenzanthracene, 1,2-benzanthracene, and 10-methyl-1,2-benzanthracene. Several other polycyclic aromatic hydrocarbons (PAHs) are carcinogenic. Various synonyms and abbreviations have been applied to many of these PAHs.

ZoBell, C.E. and G.F. McEwen.

The Lethal Action of Sunlight upon Bacteria in Sea Water.

Biological Bulletin. 68(1):93-106. February 1935.

Key Words: bacteria, surface water (marine).

Abstract:
Observations on the vertical, diurnal, and seasonal distribution of bacteria in the sea fail to show evidence of a lethal action of sunlight. While the seasonal fluctuation in the bacterial population is more or less inversely proportional to the intensity of sunlight, it is recognized that there are multifarious interlinked biological, physical, and chemical factors which also influence the bacterial population of sea water.

Controlled laboratory experiments reveal that at this latitude sunlight has a feeble lethal action on bacteria in the uppermost few millimeters of sea water, but even shallow layers of sea water are not sterilized by prolonged exposure.

Virtually no bactericidal radiations penetrate sea water three meters, and the intensity is materially reduced by passage through 10 cm of sea water.

Zoltek, J., Jr.

Phosphorus Removal by Orthophosphate Nucleation.

JWPCF. 46(11):2498-2520. November 1974.

Key Word: phosphates, filtration.

Abstract:

From batch experiments, it was found that nucleation of orthophosphate on phosphate rock followed a rate equation of the form

$$\frac{dc}{dt} = \frac{kA}{V} C^n$$

When a second-order rate equation for steady-state nucleation of orthophosphate in packed columns of phosphate rock was used, it was found that the rate constant increased with increasing temperature, pH, and fluoride concentration, and decreased with increasing concentrations of magnesium sulfate, ammonium chloride, and bicarbonate ion.

The use of commercially available phosphate rock in a packed column system seems to have some promise as a phosphate removal system, when it is used as a polishing process after lime treatment.

The surface area of phosphate rock ore must be increased to at least 100 sq m/g before it may be considered for removing phosphate from wastewater treatment plant secondary effluents.

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15. SUPPLEMENTARY NOTES

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16. ABSTRACT

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Toxic Diseases			
Sewage Treatment			
Sludge Disposal			

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